GEORGIA INSTITUTE OF TECHNOLOGY — OFFICE OF CONTRACT ADMINISTRATION

PROJECT ADMINISTRATION DATA SHEET

[X] ORIGINAL [ ] REVISION NO. _____

Project No. A-3606 GTRI/~~GIT~~X DATE 8 /02 /83

Project Director: James L. Clark ~~School~~/Lab TAL-ET

Sponsor: Georgia Office of Energy Resources

Type Agreement: Contract dated 7/21/83 under DOE Prime

Award Period: From 7/1/83 To 12/30/83 (Performance) _____ (Reports)

Sponsor Amount:	This Change	Total to Date
Estimated: $		$ 13,764
Funded: $		$ 13,764

Cost Sharing Amount: $ _____ Cost Sharing No: _____

Title: "Weatherization Assistance Program Analysis"

ADMINISTRATIVE DATA — OCA Contact John W. Burdette X4820

1) Sponsor Technical Contact:

2) Sponsor Admin/Contractual Matters:

Rob Harvey
Georgia Office of Energy Resources
270 Washington Street, S.W.
Atlanta, Georgia 30334

Defense Priority Rating: NA — Military Security Classification: NA

(or) Company/Industrial Proprietary: NA

RESTRICTIONS

See Attached -- Supplemental Information Sheet for Additional Requirements.

Travel: Foreign travel must have prior approval — Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

Equipment: Title vests with None proposed

COMMENTS:

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FORM OCA 4:383

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION/CLOSEOUT SHEET

Date January 20, 1984

Project No. A-3606 ~~School~~/Lab TAL

Includes Subproject No.(s) NONE

Project Director(s) James L. Clark GTRI / ~~GTRI~~

Sponsor GA. Office of Energy Resources

Title "Weatherization Assistance Program Analysis"

Effective Completion Date: 11/30/83 (Performance) _____ (Reports)

Grant/Contract Closeout Actions Remaining:

- [ ] None
- [X] Final Invoice or Final Fiscal Report
- [ ] Closing Documents
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Continues Project No. _____ Continued by Project No. _____

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Form OCA 60:1028

ENGINEERING EXPERIMENT STATION
Georgia Institute of Technology
A Unit of the University System of Georgia
Atlanta, Georgia 30332

5 August 1983

Mr. Bernard Powell
Program Operations
Georgia Office of Energy Resources
270 Washington St. SW
Atlanta, Georgia 30334

Dear Bernard:

Under the terms of our contract with your office to provide assistance for the Weatherization Assistance Program, we are required to provide you with a monthly report of progress. Since the effective date of the contract was July 1, 1983, we owe you a report for the month of July.

I am certain that you understand that only a limited amount could have been accomplished, since the contract was actually implemented on July 22. In fact, we must admit that during July there was no true progress against the scope of work of the program. Nevertheless, I am submitting the attached very brief report in order to comply with the terms of the contract.

A month from now, when we have indeed made progress, I will provide you with a meaningful report of our activities.

Sincerely,

James L. Clark
Senior Research Engineer

Project No. A-3606
WEATHERIZATION ASSISTANCE PROGRAM ANALYSIS

Monthly Progress Report No. 1
July 1983

In response to Georgia Tech's proposal number TA/ET-1248, "Weatherization Assistance Program Analysis," an unnumbered contractual agreement was signed with the Georgia Office of Energy Resources on July 22, 1983. The contract is dated July 21, 1983 with a period of performance of July 1, 1983 through September 30, 1983 and an authorized funding level of $13,764.

This project was assigned a Georgia Tech project number A-3606, and Mr. James L. Clark, Senior Research Engineer, was designated the Project Director.

An initial project meeting was held on July 22, involving Messrs. Phil Whitlow, Bernard Powell, and Rob Harvey of OER and Messrs. Jim Clark and Tom McGowan of Georgia Tech. Two specific requests were made by OER with regard to the sequence of activities within the scope of work.

First, item #6, the development of a formula for allocation of funds to the various regions of the state should be a priority area. It was noted that it will be necessary for the formula to allow for changing boundaries of the regions and that Atlanta and Fulton County must be considered separately.

Second, item #5, the development of an updated Energy Savings Worksheet, should be delayed since DOE may be coming out with new forms and specifications themselves.

Rob Harvey noted that it will be necessary for this project to be paid from two separate funds and requested that Georgia Tech provide monthly invoices in a manner to minimize the difficulties in this.

No further progress was made during the course of the month, and no expenditures of funds were made during July.

Monthly Report No. 2
August 1983

Project No. A-3606
WEATHERIZATION ASSISTANCE PROGRAM ANALYSIS

During this period, emphasis has been placed on development of a formula for allocation of program funds to various regions of the State. This effort is identified as Task 6 in the project scope of work.

The DOE regulations governing the Weatherization Assistance Program list eight topics which the State's final implementation plan should address for each area of the State to be served by the program. The regulations also indicate that the funds are to be allocated to areas on the basis of the relative need for a weatherization project by low-income persons, taking into account these same eight factors. The factors are as follow:

1. The number of dwelling units to be weatherized.
2. The climatic conditions.
3. The type of weatherization work to be done.
4. The need for weatherization assistance among low-income persons.
5. The amount of energy to be conserved.
6. Mechanisms for providing sources of labor.
7. An estimate of the number of eligible dwelling units in which the elderly reside.
8. An estimate of the number of eligible dwelling units in which the handicapped reside.

The initial concept for the funding allocation formula is to provide an equation of the form:

$$A = F\,[W_1X_1 + W_2X_2 + \cdots + W_8X_8]$$

where A = Allocation to a region
F = Total funds to be allocated
W_i = Weighting factors to reflect relative importance
X_i = Quantitative measures of each of the eight factors

In such a formula, the X_i must be normalized so that the total of the allocations to the regions equals the total of the funds to be allocated.

There are two basic issues involved in developing such a formula. First, quantitative data must be available for each region which reflect each of the factors in the same manner. Second, appropriate weighting factors must be selected to indicate the relative importance of each of the parameters.

Project activities to this point have been directed toward identifying appropriate quantitative measures. Each of these is discussed below.

Number of units to be weatherized. As is the case with several of the factors, the actual number of units to be weatherized may well be determined by the funds allocated rather than being an appropriate factor for determining the allocation. It is not likely that an accurate count can be made in advance. Two possible alternatives are evident. One is the use of agency forecasts of units which they could weatherize if funding were available. These forecasts may be adjusted based on comparison of prior years' records of forecasts and actual weatherization activities.

The second alternative is to use the total number of eligible dwelling units in the region. It is suggested that the number of eligible dwelling units is the appropriate allocation factor, with the available funding determining the actual number of units weatherized. Under this approach, an indicator of the number of eligible dwelling units is required.

Prior to 1970, the Census Bureau collected data on "dilapidated" housing. This classification was found to be too subjective, and the 1970 and

1980 censuses collected data on housing lacking all or some basic plumbing facilities. While a dwelling's lack of plumbing may not indicate the need for weatherization, the number of dwellings lacking plumbing facilities may well be a good indicator of the number of dwellings in the same region which require weatherization. For this reason, these data, available from the Census Bureau's 1980 Summary Tape File 3, may be used to reflect the first factor of the formula.

The climatic conditions. Thirty-year average data is available from the National Oceanographic and Atmospheric Administration for both heating degree days and cooling degree days for nine zones of Georgia. These data reflect the climatic conditions of importance to the program. As would be expected, heating requirements are dominant in the northern part of the State while cooling requirements are dominant in the southern part. When the heating degree days and cooling degree days are added, there is less than a 10% variation from the median.

A serious consideration is whether cooling requirements are important to the funding allocation. Under the Weatherization Assistance Program, only very limited measures may be implemented to assist in meeting cooling needs of the dwellings. For this reason, it is recommended that the cooling degree day data either be disregarded or weighted very low in the allocation formula.

Weatherization work to be done. For two reasons it is recommended that this factor not be included in the funding allocation formula. First, the types of weatherization measures to be implemented will be determined by economic issues, site specific conditions, and available funding. As with the number of actual dwellings to be weatherized, the weatherization work to be done should be a result rather than a cause of funding allocation. Second,

for similar climatic conditions the work to be done in different areas should be the same. Thus, having both the climatic conditions and the work to be done as factors in the formula should be redundant.

Need for weatherization assistance among low-income persons. This consideration may also be reflected by Census Bureau data. The data indicate both income level and poverty status. It is suggested that the specific Census Bureau summary category which best reflects this issue is the number of families and non-family householders who are below the established poverty level.

While these data are available for each county on Summary Tape File 3, there is no summary currently available which cross categorizes poverty status with lack of plumbing in the dwelling. Although it may reasonably be assumed that poverty status and substandard housing would correlate well, the data will not be available until Summary Tape File 5 is released. If perfect correlation is assumed, there is no need to include both factors in the formula. If no correlation is assumed, the currently available data are suitable for developing the formula.

It is suggested that an interim formula may be developed which will utilize currently available data, as well as a final formula which will use cross categorized data when it becomes available.

Amount of energy to be conserved. This consideration, again, will correlate to the climatic conditions, the number of dwellings to be weatherized, and the weatherization work to be done. It is suggested that including it as a factor in the allocation formula will be redundant.

Mechanisms for providing sources of labor. This consideration essentially indicates whether an agency is capable of implementing the program

effectively. It does not appear to be a factor which can be handled in the same manner as the others. It may well be that this is a yes/no factor, with "no" meaning that no funds should be allocated at all. Thus, rather than being included as a weighted term in the formula described above, it should be a factor (zero or one) which reflects the existance of a capable implementing agency and by which the computed allocation is multiplied. As an alternative, a percentage factor may be used which reflects a rating of the agency's effectiveness in utilizing program funds.

Eligible dwellings in which the elderly reside. Age is also reflected in the Census Bureau data. If a definition of "elderly" is accepted, the Summary Tape File 3 will indicate the number of elderly in each county. The same problem exists, however, in cross categorization of sub-standard housing with age. Such summary data have not yet been released. Again, an interim formula may be developed which reflects total elderly population with a final formula which can later reflect the actual number of sub-standard dwellings in which the elderly reside.

Eligible dwellings in which the handicapped reside. Handicap status is indicated in census data in terms of both work handicaps and transportation handicaps. Work handicaps appear to be more closely related to the interests of the program. Again, the cross categorization of housing condition with handicap status is not yet available, and an interim formula would be required.

In summary, interim and final formulas for funding allocation will be developed will each involve the product of three items:

- The total funding available.
- The existance (0 or 1) or rating of the implementing agency.

- The sum of five weighted factors reflecting the DOE guidelines.

For the interim formula, the five factors will be as follow:

1. The number of dwelling units in the area which lack all or some basic plumbing.
2. The heating (and possibly cooling) degree days.
3. The number of families and non-family householders below the poverty level.
4. The number of elderly persons.
5. The number of persons with work disabilities.

This formula may be implemented with currently available data. For the final formula, the third, fourth, and fifth weighted factors will only reflect the number of persons or families who are cross categorized as residing in dwellings lacking all or some basic plumbing facilities. This formula may be implemented when the Census Bureau's Summary Tape File 5 is released.

The values for the weighting factors which will indicate the relative importance of the five items may be determined by the Office of Energy Resources, although Georgia Tech will provide assistance in selecting appropriate initial values.

An opportunity exists to implement the final formula before Summary Tape File 5 is released, although with some possible reduction in accuracy of the data and at some additional expense. The Public Use Microdata Samples from the 1980 census are available to the State. These data reflect a 5% sample of the population and permit generation of the desired cross categorized summaries based on the sample population rather than the total population.

Neither the suitability of using the sample population nor the difficulty and cost associated with obtaining the computer summaries from the Office of

Planning and Budget are known at this time.

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

3 October 1983

Mr. Bernard Powell
Program Operations
Georgia Office of Energy Resources
270 Washington St. SW
Atlanta, Georgia 30334

Dear Bernard:

Our third Monthly Progress Report for our project "Weatherization Assistance Program Analysis" is enclosed. Our emphasis this period has been on completing the development of the funding allocation formula and beginning the prioritization of weatherization measures.

I believe that we have completed development of a suitable funding formula, pending further comments from you or from DOE. We will provide you with revised funding share figures for each agency if you select different weighting factors, as we have discussed.

If you have any questions regarding this report, please give me a call.

Sincerely,

James L. Clark
Senior Research Engineer

Monthly Report No. 3
September 1983

Project No. A-3606
WEATHERIZATION ASSISTANCE PROGRAM ANALYSIS

Introduction

During September, work was completed on developing the funding allocation formula for distribution of program funds to various regions of the state. Preliminary results were provided to OER for review. Efforts were initiated on analysis and prioritization of weatherization measures. This activity will be the major effort for the remainder of the project.

Funding Allocation Formula

The approach presented in Monthly Report No. 2 was discussed with OER personnel, and general approval was received. Points to be resolved included the specific data to be used and the weighting of the various factors.

In contrast to what was reported previously, it was learned that the Census Bureau's Summary Tape File 5, even when it is eventually released, will not include a cross categorization of the number of persons with work disabilities with the number of dwellings lacking complete plumbing facilities. Such cross categorization was desired as an indicator of the number of handicapped persons living in housing requiring weatherization assistance. Thus, there will always be some shortcoming in the data for implementing the planned approach for the funding allocation formula.

Discussions were held with the State Data Center to determine whether appropriate cross categorizations could be developed from the Public Use

Microdata Samples tape. If cross categorization of the desired parameters were computed based on the PUMS tape, the cost was estimated by the State Data Center to be $100.

It was learned, however, that a major limitation on this approach is the degree of geographical breakdown which is available. Data is presented by county for all counties with populations over 100,000. For smaller counties, data is presented for groups of counties so that the reporting region has a population of at least 100,000. The counties are grouped approximately according to Area Planning and Development Commission districts. Such groupings are similar to those represented by the Weatherization Agencies, but there would be some discrepancies requiring adjustments of the data.

Since there is some question as to the improvement which could be obtained in the funding allocation by using this additional data, no further attempt will be made to obtain or utilize cross categorized census data unless requested by OER.

The data used in the formula were drawn from National Oceanographic and Atmospheric Administration data and several Census Bureau publications and included the following items:

1. Heating degree-days.
2. Dwelling units lacking complete plumbing facilities for exclusive use (total of owner and renter occupied units).
3. Families and non-family householders with income below the poverty level.
4. Persons 65 years of age and over.
5. Non-institutional persons 16 to 64 years with a work disability.

Data were collected for each of these items for each county in Georgia

and for the City of Atlanta. Data for Fulton County were recorded excluding the City of Atlanta, to aid in allocating funds between agencies serving the city and the remainder of the county. A listing of the weatherization agencies and the counties they represent was obtained from OER.

These data were used in a micro-computer based program for computation of the funding allocation formula. A sample of the output from this program is included with this report as an appendix, and the methods represented in the formula are discussed below.

Each of the five parameters was divided by the average over all counties, in order to reflect proportionate need in the county as indicated by that parameter. The five ratios for each county were multiplied by weighting factors reflecting relative importance, and then added. This procedure resulted in "County Factors" which averaged 1.00 and which should reflect overall need for assistance from the program.

The county factors for counties represented by each agency were summed as an "Agency Factor" to indicate need within the region served by the agency. Then, a funding share was computed as the ratio of the agency factor to the total of all agency factors.

Two minor difficulties were encountered in implementing this technique. First, there are thirteen counties for which there currently no Weatherization Agency -- Berrien, Butts, Catoosa, Cook, Crawford, Effingham, Hall, Jackson, Newton, Oconee, Spalding, Upson, and Warren. The formula neither allocates nor reserves any funing for activities in these counties. It was decided that since there is no active agency in these counties, any provisions should be made outside of the formula, but data is presented in the computer output which indicates the extent of the need in the state which is in these

un-served counties.

The second difficulty arose from the fact that Ware County is served by both the Slash Pine Community Action Agency, Inc. and the Migrant and Seasonal Farmworkers Association, Inc. This conflict was resolved by allocating the county factor for Ware County 60% to the Community Action Agency and 40% to the Farmworkers Association, as recommended by OER.

An option was provided which would permit use of an "Agency Rating" which would proportionately increase or decrease an agency's "Agency Factor." This would lead to increase or decrease in that agency's funding share, accompanied by equitable adjustment of the funding share for each of the other agencies. In the initial computations, all agencies were assigned agency ratings of 1.00.

The critical item in this process is selection of proper weighting factors for the five parameters indicating need. Preliminary weighting factors were selected by OER as follow:

Units w/o plumbing	0.1
Heating degree-days	0.3
Poverty families	0.4
Population 65 and over	0.1
Handicapped population	0.1

Two computer runs were made -- one with these weighting factors and one with the factors for "Units w/o Plumbing" and "Poverty Families" swapped to indicate the sensitivity of funding allocation to the weighting factors. The results for each run were submitted to OER for review, and a copy of the first is the example included with this report.

Prioritization of Weatherization Measures

Work was initiated during September on develpment of new priority orders

for the various weatherization measures undertaken by the program. This activity will involve review of DOE guidelines for selection of weatherization measures, engineering analysis of the energy to be saved by various techniquies, and economic analysis of the installation, operation, and maintenance costs and the value of the fuel savings in order to rank the opportunities.

The initial efforts have been directed at defining the "typical" house to be addressed by the program, in terms of physical characteristics and current energy efficiency. It is anticpated that since construction techniques differ around the state more than one baseline house will be defined. Once this is accomplished, a theoretical computation of energy savings from various measures will be performed. An attempt will be made to collect actual "before and after" data on houses which have been weatherized in the past in order to determine whether adjustments must be made to the theoretical calculations in order to obtain more representative estimates of savings.

Appendix

FUNDING ALLOCATION FORMULA SAMPLE PRINTOUT

WEATHERIZATION ASSISTANCE PROGRAM
Funding Allocation Formula

	Units w/o Plumbing	Heating Deg-Days	Poverty Families	Pop. Over 65	Handicap. Pop.	
Wt. Factor->	0.10	0.30	0.40	0.10	0.10	
Norm ->	372	2522	2003	3059	2253	
County						County Factor
Appling	219	1778	1434	1537	1405	0.66936
Atkinson	211	1932	632	673	623	0.46245
Bacon	53	1778	844	970	798	0.46144
Baker	83	1932	386	484	341	0.36021
Baldwin	328	2471	1540	2731	2221	0.87754
Banks	229	3284	440	1003	741	0.60583
Barrow	343	3422	1361	2347	1646	0.92091
Bartow	608	3368	2100	3857	3167	1.25017
Ben Hill	173	1932	1520	2047	1219	0.70090
Berrien	128	1932	989	1525	1064	0.55883
Bibb	630	2471	10290	15209	12021	3.54869
Bleckley	279	2471	690	1191	828	0.58248
Brantley	98	1778	574	801	689	0.40927
Brooks	515	1932	1546	2033	1158	0.79491
Bryan	208	1778	666	755	813	0.46122
Bulloch	695	2306	2541	3265	2541	1.18814
Burke	793	2306	1786	2137	1590	0.98466
Butts	339	2471	662	1345	1051	0.60795
Calhoun	242	1932	569	810	385	0.45212
Camden	224	1778	960	1065	965	0.54111
Candler	181	2306	682	1032	646	0.52162
Carroll	760	2646	3291	5571	4145	1.54239
Catoosa	168	3368	1745	3076	2563	1.00861
Charlton	189	1778	476	681	583	0.40555
Chatham	709	1778	12873	20240	12546	4.19100
Chattahoochee	63	2646	334	191	813	0.44077
Chatooga	319	3368	1428	2617	2111	0.95087
Cherokee	455	3422	1983	3858	2914	1.18089
Clarke	336	3422	6034	5516	3433	2.03498
Clay	228	1932	437	548	274	0.40851
Clayton	362	2646	4064	6194	7955	1.77914
Clinch	237	1932	571	609	487	0.44913
Cobb	653	3422	7232	15642	14736	3.19208
Coffee	340	1932	2175	2642	2545	0.95490
Colquitt	381	1932	2553	4216	2963	1.11140
Columbia	378	2306	1527	1982	2435	0.85377
Cook	167	1932	897	1549	973	0.54770
Coweta	650	2646	2422	4153	2974	1.24097
Crawford	333	2471	494	707	559	0.53010
Crisp	219	1932	1776	2242	1259	0.77254

Dade	198	3368	782	999	986	0.68652
Dawson	71	3422	345	504	352	0.52721
Decatur	599	1932	1856	2974	1905	0.94331
DeKalb	961	3422	16385	32269	22816	6.00462
Dodge	393	2471	1757	2082	1610	0.89002
Dooly	295	1932	1169	1402	942	0.63025
Dougherty	523	1932	6335	6872	5752	2.11534
Douglas	238	2646	1484	3219	3098	0.91784
Early	446	1932	1269	1688	906	0.69858
Echols	62	1932	204	261	207	0.30499
Effingham	358	2306	1027	1531	1347	0.68553
Elbert	488	3284	1418	2353	1333	0.94117
Emanual	581	2306	1825	2433	1840	0.95621
Evans	187	1778	746	1017	660	0.47332
Fannin	347	3422	1415	2123	1458	0.91710
Fayette	220	2646	623	1764	1284	0.61302
Floyd	543	3368	4071	8932	5627	1.90131
Forsyth	265	3422	1180	2300	1745	0.86664
Franklin	223	3284	1258	1987	1254	0.82248
Fulton (ex Atl)	648	3422	3844	11879	6122	2.00896
Atlanta	2168	3422	41458	47481	30004	12.15184
Gilmer	299	3422	936	1369	1203	0.77258
Glascock	70	2306	189	328	213	0.35110
Glynn	236	1778	3186	5871	4031	1.28197
Gordon	351	3368	1629	2862	2080	1.00624
Grady	404	1932	1743	2550	1540	0.83824
Greene	540	2471	995	1598	920	0.73096
Gwinnett	649	3422	3618	8117	7199	1.88892
Habersham	303	3284	1436	2614	2043	0.93505
Hall	659	3422	3390	7171	5584	1.74349
Hancock	577	2471	987	1089	738	0.71460
Haralson	280	2646	1170	2100	1472	0.75770
Harris	602	2646	1019	1826	1122	0.78966
Hart	325	3284	1236	2201	1500	0.86343
Heard	237	2646	412	766	621	0.51341
Henry	511	2646	1381	3044	2234	0.92664
Houston	420	2471	2839	3841	5505	1.34368
Irwin	181	1932	702	1196	592	0.48408
Jackson	400	3422	1405	2714	2048	0.97486
Jasper	258	2471	577	991	458	0.53131
Jeff Davis	196	1932	726	1138	1001	0.50916
Jefferson	688	2306	1840	2317	1275	0.95911
Jenkins	353	2306	925	994	948	0.62856
Johnson	333	2471	784	1109	725	0.60852
Jones	314	2471	793	1230	1110	0.62625
Lamar	267	2646	719	1440	938	0.61888
Lanier	97	1932	494	639	484	0.39695
Laurens	806	2471	2667	4085	3052	1.31226
Lee	167	1932	594	763	482	0.43971
Liberty	398	1778	1904	1249	2067	0.83131
Lincoln	230	3284	418	807	522	0.58558
Long	105	1778	343	386	367	0.33717
Lowndes	566	1932	4558	5583	4174	1.65993
Lumpkin	190	3422	645	946	798	0.65336

McDuffie	451	2306	1394	1740	1469	0.79607
McIntosh	226	1778	831	898	842	0.50497
Macon	433	2646	1355	1571	1073	0.80079
Madison	277	3284	1086	1758	1299	0.79717
Marion	310	2646	538	607	505	0.54786
Meriwether	822	2646	1555	2533	1419	0.99215
Miller	159	1932	657	927	448	0.45399
Mitchell	361	1932	1818	2279	1505	0.83124
Monroe	471	2471	749	1531	1061	0.66735
Montgomery	177	2471	506	845	557	0.49497
Morgan	305	2471	747	1400	659	0.60018
Murray	309	3368	1010	1518	1412	0.79777
Muscogee	454	2646	11054	14280	12050	3.64564
Newton	701	2471	1709	3377	1977	1.02189
Oconee	183	3422	554	1075	728	0.63442
Oglethorpe	359	3284	576	1062	636	0.66522
Paulding	358	3368	1381	2302	2012	0.93728
Peach	363	2471	1523	1586	1528	0.81537
Pickens	421	3422	779	1442	1009	0.76782
Pierce	169	1778	977	1263	1142	0.54404
Pike	234	2646	409	1005	599	0.51884
Polk	451	3368	2179	3971	3016	1.22075
Pulaski	202	2471	813	1145	716	0.57985
Putnam	229	2471	730	1106	731	0.56993
Quitman	168	1932	293	339	214	0.35413
Rabun	199	3284	803	1463	968	0.69536
Randolph	493	1932	1080	1471	675	0.65614
Richmond	660	2306	11221	14397	11550	3.67558
Rockdale	171	2471	1029	2410	1804	0.70428
Schley	122	2646	326	426	245	0.43751
Screven	516	2306	1564	1730	1186	0.83461
Seminole	185	1932	759	1134	664	0.49770
Spalding	423	2646	2923	4915	3502	1.32830
Stephens	261	3284	1372	2600	1694	0.89503
Stewart	357	1932	725	833	566	0.52298
Sumter	804	1932	2195	3111	2010	1.07527
Talbot	478	2646	459	863	513	0.58599
Taliaferro	149	2471	243	426	209	0.40578
Tattnall	259	1778	1640	1977	1469	0.73848
Taylor	291	2646	626	1028	650	0.58052
Telfair	272	1932	1041	1544	1091	0.60976
Terrell	521	1932	1142	1519	710	0.67917
Thomas	605	1932	2721	4331	2749	1.19946
Tift	435	1932	2401	3102	2490	1.03817
Toombs	322	1778	2042	2205	2191	0.87518
Towns	73	3284	518	921	448	0.56377
Treutlen	219	2471	550	808	676	0.51912
Troup	1080	2646	3456	6314	3799	1.67033
Turner	210	1932	886	1092	732	0.53143
Twiggs	425	2471	584	884	589	0.57994
Union	207	3422	967	1376	876	0.73974
Upson	679	2646	1381	3483	2202	0.98475
Walker	430	3368	2942	5903	4281	1.48674
Walton	541	3422	1828	3138	2331	1.12366

Ware	392	1778	2728	4010	3441	1.14546
Warren	280	2306	623	884	498	0.52506
Washington	962	2471	1613	2250	1468	1.01349
Wayne	254	1778	1439	2037	1908	0.71844
Webster	133	1932	224	285	180	0.32766
Wheeler	135	2471	548	734	561	0.48861
White	170	3422	738	1207	764	0.67357
Whitfield	425	3368	3013	5367	4499	1.49173
Wilcox	180	1932	797	1029	617	0.49843
Wilkes	333	3284	955	1546	774	0.75585
Wilkinson	407	2471	629	1126	730	0.59825
Worth	488	1932	1341	1939	1143	0.74298
					Sum:	160.00000

Agency	Total of County Factors	Agency Rating	Agency Factor	Funding Share
1 Albany Urban League Albany, GA (Dougherty)	2.115	1.000	2.115	0.014261
2 Altamaha Area CAA, Inc. Reidsville, GA (Appling, Bulloch, Candler, Evans Jeff Davis, Tattnall, Toombs, Wayne)	5.694	1.000	5.694	0.038385
3 ACTION, Inc. Athens, GA (Barrow, Clarke, Elbert, Greene, Madison, Morgan, Oglethorpe, Walton)	7.814	1.000	7.814	0.052682
4 Central Savannah River Area EOA, Inc. Augusta, GA (Burke, Columbia, Emanuel, Glascock, Jefferson, Jenkins, Lincoln, McDuffie, Richmond, Screven, Taliaferro, Wilkes)	11.787	1.000	11.787	0.079464

5	Clayton Co. CSA, Inc. Forrest Park, GA (Clayton, Fayette, Henry)	3.319	1.000	3.319	0.022374
6	Coastal Georgia Area CAA, Inc. Brunswick, GA (Bryan, Camden, Glynn, Liberty, Long, McIntosh)	3.958	1.000	3.958	0.026682
7	Coastal Plain Area EOA, Inc. Valdosta, GA (Ben Hill, Brooks, Echols, Irwin, Lanier, Lowndes, Tift, Turner)	5.911	1.000	5.911	0.039853
8	Community Action for Improvement, Inc. LaGrange, GA (Carroll, Coweta, Heard, Merriwether, Troup)	5.959	1.000	5.959	0.040176
9	DeKalb County EOA, Inc. Decatur, GA (DeKalb)	6.005	1.000	6.005	0.040482
10	Economic Opportunity Atlanta, Inc. Atlanta, GA (Douglas, Fulton, Gwynnett, Rockdale)	5.520	1.000	5.520	0.037214
11	EOA for Savannah-Chatham County Areas Savannah, GA (Chatham)	4.191	1.000	4.191	0.028255
12	Enrichment Services Program, Inc. Columbus, GA (Chattahoochee, Clay, Harris, Muscogee, Quitman, Randolph, Stewart, Talbot)	7.404	1.000	7.404	0.049915
13	Heart of Georgia CAA, Inc. Eastman, GA (Bleckley, Dodge, Laurens, Montgomery, Pulaski, Telfair, Treutlen, Wheeler, Wilcox)	5.975	1.000	5.975	0.040285
14	Macon-Bibb County EOC Macon, GA (Bibb, Jones, Lamar)	4.794	1.000	4.794	0.032319
15	Marietta/Cobb CSC Marietta, GA (Cobb)	3.192	1.000	3.192	0.021520

16	Middle Georgia CAA, Inc. Warner Robins, GA (Houston, Monroe, Peach, Twiggs)	3.406	1.000	3.406	0.022965
17	Migrant and Seasonal Farmworkers Assoc. Waycross, GA (Ware[40%])	0.458	1.000	0.458	0.003089
18	Ninth District Opportunity, Inc. Gainesville, GA (Banks, Dawson, Forsyth, Franklin, Habersham, Hart, Lumpkin, Rabun, Stephens, Towns, Union, White)	8.841	1.000	8.841	0.059607
19	North Georgia CAA, Inc. Jasper, GA (Cherokee, Fannin, Gilmer, Murray, Pickens, Whitfield)	5.928	1.000	5.928	0.039964
20	Northwest Georgia EDA, Inc. LaFayette, GA (Chattooga, Dade, Walker)	3.124	1.000	3.124	0.021062
21	Overview Corporation Milledgeville, GA (Baldwin, Hancock, Jasper, Johnson, Putnam, Washington, Wilkinson)	4.914	1.000	4.914	0.033126
22	Slash Pine CAA, Inc. Waycross, GA (Atkinson, Bacon, Brantley, Charlton Clinch, Coffee, Pierce, Ware[60%])	4.374	1.000	4.374	0.029489
23	Southeast Energy Technical Group Atlanta, GA (City of Atlanta)	12.152	1.000	12.152	0.081925
24	Southeast Georgia CAC, Inc. Moultrie, GA (Baker, Calhoun, Colquitt, Decatur, Early, Grady, Lee, Miller, Mitchell, Seminole, Terrell, Thomas, Worth)	9.248	1.000	9.248	0.062348

25	Tallatoona EOA, Inc. Cartersville, GA (Bartow, Floyd, Gordon, Haralson, Paulding, Polk)	7.073	1.000	7.073	0.047687
26	West Central Georgia CAC, Inc. Montezuma, GA (Crisp, Dooley, Macon, Marion Schley, Sumter, Taylor, Webster)	5.172	1.000	5.172	0.034871
	Sub-total:	148.330		148.330	1.000000
	No Agency:	11.670			
	Total:	160.000			

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
Atlanta, Georgia 30332

14 November 1983

Mr. Bernard Powell
Program Operations
Georgia Office of Energy Resources
270 Washington St. SW
Atlanta, Georgia 30334

Dear Bernard:

Our fourth Monthly Progress Report for our project "Weatherization Assistance Program Analysis" is enclosed. Our emphasis this period has been on analysis of the costs and energy savings for various weatherization measures. We have also attempted, to a limited extent, to compare the projected savings to the measured savings on a sample of houses weatherized in recent years.

Our remaining work involves an economic analysis of these costs and benefits, determining which measures are cost effective in each region of the state, and ranking the options in case all attractive measures cannot be implemented.

As is evident, we have not completed all of our work on the schedule we originally intended. Our Office of Contracts Administration has already submitted to you a request for extension of our contract through November at no additional cost. By that time we anticipate we will have completed our economic analyses and will have prepared a final report of our work.

If you have any questions regarding this report or the status of our work, please give me a call.

Sincerely,

J. L Clark

James L. Clark
Senior Research Engineer

Monthly Report No. 4
October 1983

Project No. A-3606
WEATHERIZATION ASSISTANCE PROGRAM ANALYSIS

Introduction

During October, work continued on the analysis and prioritization of weatherization measures. Both the DOE guidelines and the previous analysis conducted for the Georgia program were reviewed, and methods were developed for a theoretical prediction of energy savings from various measures. Data were obtained on a sample of houses which have been weatherized, and the apparent actual energy savings from some measures were compared to the theoretical values. Actual cost data were also obtained and will be utilized in the economic analyses to prioritize measures.

The work on this project has not been completed on the schedule originally expected. It is now anticipated that all work can be completed during November and that a final report may be issued at that time. A request has been submitted to the Office of Energy Resources to extend the contract at no additional cost.

Weatherization Measure Prioritization

The original Project Retro-Tech Job Book required each candidate dwelling for weatherization to be analyzed individually

and a priority list of weatherization measures developed. Because of difficulties encountered by project contractors in performing these analyses and the similarity of results which were obtained for similar structures, the procedure was altered to allow for predetermination of priorities for various measures on a state level.

This new system is already in operation in Georgia, and the current analysis is intended as an updating of the priorities which were established previously. Several factors have led to the need for such updating:

- Changes in the cost of energy.
- Changes in material and labor costs and the availability of additional information on these costs.
- A desire to review the established procedures to assure their accuracy.

There are two steps in conducting the analyses. The first step is to project the energy to be saved by each weatherization measure. The second is to determine the current and projected financial costs and savings from each measure and rank the measures according to their cost/benefit ratio.

Analysis of Energy Savings

If the same assumptions and procedures are used for projecting energy savings, the results should not change over time. Thus, the analysis consisted of an independent repeat of

previous projections of energy savings and should reach the same results.

One approach for such an analysis is to assume one or several typical dwelling sizes and types and investigate the changes in projected energy consumption as weatherization measures are added. With such a method, it is difficult to compare projections to actual data, since dwellings which are weatherized will seldom match the "standard" configurations.

Instead, an approach was chosen which projects savings from each measure per square foot of floor area, opaque wall area, or window area. This approach allows for easy application of the results to houses which have been weatherized in order to make comparisons between projections and actual achievements. It does introduce a few inconsistencies, however.

While many aspects of space heating loads and weatherization costs are indeed proportional to area, others are not. For example, the cost of installing or insulating foundation skirting should be proportional to perimeter rather than area. For the few such exceptions, factors were developed which should provide satisfactory results for most common dwelling configurations.

Even using a per-square-foot basis for analysis, it is necessary to make basic assumptions as to the condition of the structure prior to weatherization. For preliminary analyses, it was assumed that the dwelling is poorly protected from excess infiltration, has no insulation or limited insulation in the ceiling, has uninsulated walls and floor, and has its floor

fully-exposed to the elements.

Table 1 presents a summary of the theoretical energy savings for each of nine common weatherization measures which were analyzed for this type of dwelling. Each measure was evaluated for three different regions of the State -- north, middle, and south -- with the variation in results due to differences in seasonal heating degree-days. These preliminary results will be expanded upon in the final report to include dwellings with different pre-weatherization conditions.

The savings which could be achieved either with floor insulation or with skirting would not be additive if both were implemented. For this reason, the combination of skirting and floor insulation was included as one of the weatherization measures analyzed.

Predicted vs. Actual Savings

Data was obtained for 35 dwellings which have been weatherized in north Georgia in recent years. These data were used in an attempt to validate the calculated savings factors and to determine what adjustments should be made, if any.

Twenty-two of the houses had been weatherized with the same combination of measures -- infiltration prevention and ceiling insulation. Since introducing data from the other dwellings would introduce additional statistical uncertainties in attributing savings to individual measures, this validation was limited to these two measures and the sub-set of 22 dwellings.

TABLE 1: Projected Energy Savings
(Therms/ft^2 - year)

Type of Measure	North Georgia	Middle Georgia	South Georgia	Basis
Insulation of Uninsulated Attic from R-3 to R-22	.232	.171	.130	Floor Area
Insulation of Partially Insulated (R-10) Attic	.044	.032	.025	Floor Area
Reduce Excess Infiltration (Draft Index from 2.5 to 1.5)	.129	.095	.072	Floor Area
Insulate Floor From R-3 (No Insulation) to R-22	.232	.171	.130	Floor Area
Insulate Walls from R-3 to R-15	.215	.158	.120	Opaque Wall Area
Install Storm Windows	.604	.445	.338	Window Area
Insulate Existing Skirting	.054	.040	.030	Typical Enclosed Area
Install Skirting	.134	.099	.075	Typical Enclosed Area
Install both Skirting and Floor Insulation	.250	.184	.140	Typical Enclosed Area

Table 2 presents a summary of the predicted and actual energy savings for each of the houses. The "actual" savings are from field records of energy consumption for heating seasons before and after homes were weatherized, with an adjustment for both the base (summer) fuel consumption level and the variation in the number of heating degree-days for each year.

There is considerable scatter in the data. Two of the units actually consumed more energy after weatherization. On the other hand, three of the units experienced savings which exceeded the theoretical projections, one of them substantially. In general, however, the actual savings were in the range expected -- between zero and the full theoretical value.

There are several reasons for the actual savings to be different from the theoretical value. One of the major sources for discrepancy is the lack of information about the pre-weatherization condition of the house. This has a substantial effect on the theoretical savings from infiltration prevention. The projections in Table 2 have assumed that infiltration has been reduced by one air change per hour.

Other sources for discrepancy generally relate to changes in the utilization of the dwelling and would be very difficult to quantify. Such factors as a different family or number of occupants in the dwelling or a different number of rooms in regular use fall into this category.

The change in utilization which can be understood most readily is an improvement in occupant comfort. Weatherization

TABLE 2: Projected and Actual Energy Savings
(Therms/Year)

File Number	Predicted Savings			Actual Savings
	Attic Insulation	Prevent Infiltration	Total	
107	51.1	154.0	205.1	-65.0
111	111.7	127.7	239.4	199.1
114	106.9	205.4	312.3	104.5
128	697.0	388.9	1085.9	-121.7
130	90.8	174.5	265.3	153.1
141	144.2	277.3	421.5	162.5
147	76.9	147.9	224.8	16.3
152	275.9	154.0	429.9	185.3
189	160.3	308.1	468.4	102.3
203	104.1	200.2	304.3	316.1
260	54.6	254.1	308.7	211.5
1013	66.7	128.3	195.0	46.8
1018	338.0	188.7	526.7	256.8
1032	462.2	258.0	720.2	216.3
1043	72.1	138.6	210.7	129.0
1055	227.7	127.1	354.8	60.3
1056	292.7	334.4	627.1	148.0
1057	213.8	119.4	333.2	92.6
1092	109.5	210.4	319.9	413.1
2113	96.2	182.9	279.1	617.9
2182	151.5	291.1	442.6	147.3
2195	265.0	147.9	412.9	230.9

measures which reduce heat loss can easily result in a higher average winter time temperature throughout the house rather than resulting exclusively in fuel savings. If such a change in utilization takes place, the program benefits the occupants, but the benefits are not reflected in the actual savings shown in Table 2. This factor is believed to be the primary reason for the actual savings having a strong tendency to be less than the theoretical values.

A limited statistical analysis of the projected and actual energy savings for the 22 houses was performed. The objective of this analysis was to establish an adjustment factor which could be used to convert projected benefits to benefits actually observed as fuel savings. This factor was computed to be 49% for the median size house analyzed.

Several considerations must be made if such a factor is to be used in any evaluation of weatherization measures. First, the factor was computed for a specific combination of two weatherization measures and may not be appropriate for other measures and combinations, even though similar changes in utilization are present.

Second, the use of such a factor to indicate effectiveness of a weatherization measure disregards the true value of improved living conditions achieved through weatherization and addresses exclusively the fuel savings.

Third, the data appear to indicate that this factor tends to be smaller for larger dwellings. This suggests that

weatherization measures on small houses result more directly in fuel savings while on larger houses the benefits are mostly in comfort or other utilization measures. The data and analytical methods employed are not adequate to verify this. Further study on a larger data base using more sophisticated statistical correlation methods is required to prove this hypothesis.

Weatherization Costs

The costs to implement each of the weatherization measures are summarized in Table 3. These have been drawn from data reported by two Weatherization Assistance Program contractors. In the few instances where the data were incomplete, estimates used in the 1980 analysis of weatherization measures were used. The costs are presented in terms of floor, wall, or window area, as are the benefits.

These data, the projected energy savings, and current fuel costs will be used to compute benefit/cost ratios for each of the measures in each region of the state. These will provide the basis for both identifying which measures are cost effective and the priority which should be placed in the event that funding is inadequate to implement all cost-effective measures on a particular dwelling.

TABLE 3: Cost of Weatherization Measures

Type of Measure	Material Cost	Labor Cost	Total Cost (1)
Insulation of Uninsulated Attic	12¢/ft^2 (A) 13¢/ft^2 (B)	5¢/ft^2 (A) 4¢/ft^2 (B)	17¢/ft^2
Insulation of Partially Insulated (R-10) Attic	6¢/ft^2 (A)	3¢/ft^2 (A)	9¢/ft^2
Infiltration Prevention	11¢/ft^2 (A) 12¢/ft^2 (B)	9¢/ft^2 (A) 9¢/ft^2 (B)	21¢/ft^2
Insulate Floor R-3 to R-22	21¢/ft^2 (A)(2)	6¢/ft^2 (A) 8¢/ft^2 (B)	28¢/ft^2
Insulate Walls (3)	14¢/ft^2 (B)	8¢/ft^2 (C) 4¢/ft^2 (B)	20¢/ft^2
Install Storm Windows (4)	$2.50/ft^2(B)	$1/ft^2 (B)	$3.50/ft^2
Insulate Existing Skirting	12¢/ft^2 (C)	6¢/ft^2 (C)	18¢/ft^2
Install Skirting	15¢/ft^2 (B) $1.17/ft (B)	8¢/ft^2 (B) 65¢/ft (B)	23¢/ft^2

Sources of Data Used to Develop These Costs:

(A) Mr. Will Horne, Southeast Energy Technical Group, Atlanta.
(B) Mr. Chandler Monk, Southeast Georgia Community Action Council, Moultrie.
(C) 1980 Retro-Tech evaluation with 6%/yr allowance for inflation.

Notes:

(1) All costs are based on floor area unless noted.
(2) Actual floor insulation cost is 26¢/ft^2 of insulation. This is equivalent to 21¢/ft^2 of floor area.
(3) Based on opaque wall area.
(4) Based on window area.

A-3606

Project No. A-3606

WEATHERIZATION ASSISTANCE PROGRAM ANALYSIS

Draft Final Report

Submitted to:

Georgia Office of Energy Resources
270 Washington Street, S.W.
Atlanta, Georgia 30034

Prepared by:

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November 1983

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List of Tables and Figures

I. INTRODUCTION

The dramatic increases in home heating fuel prices have placed a serious financial burden on economically-disadvantaged families. The Weatherization Assistance Program, funded by the U.S. Department of Energy, provides State Energy Offices with a means to assist them to improve the energy effectiveness of their homes. Through this program, various common energy conservation measures are implemented to reduce unnecessary heat losses.

When fuel prices are low, incentives exist which discourage investment in energy conserving construction. This is true for all economic levels of society. As fuel prices rise, the incentives change, and many weatherization measures can be justified economically for existing houses.

Unfortunately, the economically-disadvantaged often do not have the capital resources available to implement these measures. Since they are not able to take effective steps to offset rising fuel prices, these people begin to assume a disproportionate share of the national fuel bill and may be forced into seriously reduced standards of living.

The basic role of the Weatherization Assistance Program is to permit disadvantaged households to implement the same conservation measures as are justifiable for those who are more financially able.

The Georgia Office of Energy Resources implements this program through twenty-six contractors who provide the materials

and labor for the weatherization efforts, as well as local management of the program. These contracting agencies cover all but thirteen of the 159 counties of the state.

Two particular areas of concern have arisen in the implementation of the program. First, are the guidelines to the agencies up-to-date in their recommendations on which weatherization measures to implement? These guidelines address both which weatherization measures are economically justified and which should receive priority attention if funds are inadequate to implement all justifiable measures. Such guidelines can become outdated as material, labor, and fuel costs change.

Second, are the State's funds for the program being allocated to the various agencies equitably? The Department of Energy has identified general topics to be addressed in allocating funds to areas of the state, but a quantitative method is not presented, and the principles being used by Georgia have not been well documented.

This report presents the findings from a study conducted by the Georgia Institute of Technology to assist the Georgia Office of Energy Resources in addressing these two concerns. Section II discusses various common home weatherization measures and the projected benefits from each. Section III discusses the costs and economics of these measures and suggests priorities by types of houses and regions of the state. Section IV presents a quantitative method for determining relative need for assistance in each area and the share of program funding which should be

allocated to each contracting agency.

II. PROJECTED BENEFITS FROM WEATHERIZATION MEASURES

The original Project Retro-Tech Job Book required each candidate dwelling for weatherization assistance to be analyzed individually and a priority list of weatherization measures to be developed. Because of difficulties encountered by project contractors in performing these analyses and the similarity of results which were obtained for similar structures, the procedure was altered to allow for predetermination of priorities for various measures on a state level.

This new system is already in operation in Georgia, and the current analysis is intended as an updating of the priorities which were established previously. Several factors have led to the need for such updating:

- Changes in the cost of energy.
- Changes in material and labor costs and the availability of additional information on these costs.
- A desire to review the established procedures to assure their accuracy.

There are two steps in conducting the analyses. The first step is to project the energy to be saved by each weatherization measure. The second is to determine the current and projected financial costs and savings from each measure and rank the measures according to their benefit/cost ratio.

This section of this report addresses the first step and

discusses common weatherization measures, characteristics of existing dwellings which affect the potential benefits from weatherization, projections of these benefits for various houses and regions of the state, and a comparison of projected benefits and actual fuel savings for a limited sample of dwellings which have been weatherized.

A. Weatherization Measures

The Department of Energy guidelines, as presented in the Project Retro-Tech Job Book, identify five categories of heat loss for which conservation measures must be analyzed and prioritized by the State:

1. Heat loss by conduction through uninsulated ceilings.
2. Heat loss by conduction through partially insulated ceilings.
3. Heat losses by conduction through floors.
4. Heat losses by conduction through uninsulated walls.
5. Heat losses by conduction and infiltration through single pane glass windows.

Common conservation measures which address these heat losses include added insulation in ceilings/roofs, floors, and walls; installation and insulation of foundation skirting; and installation of storm windows. Each of these measures are discussed below.

Ceiling Insulation. Heat loss by conduction through

uninsulated ceilings and roofs can be appreciable. Corrective measures involve addition of suitable insulating materials in a manner appropriate to the style and condition of the dwelling. The most common method is the use of blown, loose-fill fiberglass insulation between the ceiling joists in the attic area.

In some dwellings this is not practical due to the design, while in others it is inappropriate because of the inadequacy of the ceiling materials to support the added weight. In such instances, other approaches to increasing the thermal resistance of the ceiling/roof must be taken.

The thermal resistance is specified in terms of "R-value," defined in units [hr ft^2 ^oF per Btu]. Typical uninsulated ceilings have an R-value of 3.0 while the desired value in Georgia is R-22. Ceilings have often been insulated to a lesser degree. Improving partially-insulated ceilings can also be cost effective, although the benefit per dollar invested is less than is achieved on completely uninsulated ceilings.

Floor Insulation. Insulation of floors is appropriate when the foundation design exposes the floor to winter winds. Fiberglass batt insulation is usually installed between the floor joists and supported by spring wires. The analysis of potential benefits assumes that the uninsulated floor has an effective thermal resistance of R-3 and that this will be increased to R-22.

The benefits which may be achieved by insulating the floors is dependent on the degree of exposure, which may be modified by

installation of skirting at the perimeter of the foundation to restrict air movement beneath the house.

Wall Insulation. In many cases, the insulation of existing walls may be an extremely difficult task. Whether it is appropriate in a specific dwelling is influenced more by the barriers to performing the job than by the economics. The analyses in this report assume that the contractor, with guidance from the Office of Energy Resources, will undertake wall insulation only when it is truly a practical weatherization measure.

In cases where wall insulation may be added, the most common method is blowing fiberglass insulation into the cavity in houses constructed with stud walls. Such procedures may increase the thermal resistance of the wall from approximately R-3 to R-15. Higher R-values cannot normally be achieved due to space limitations inside standard walls.

Installation of Foundation Skirting. As noted above, a skirting around the foundation of the house can reduce the heat loss through the floor by reducing the exposure of the floor to ambient air flow. The analysis of potential benefits assumes that the exposure factor is reduced from 1.0 to 0.5 by the installation of skirting.

Either floor insulation or perimeter skirting may be installed to reduce these heat losses. The two may be installed on the same house, but the benefits will be less than the sum of the benefits from performing the measures individually. Since

the combination can still be cost effective, this is analyzed as a weatherization measure in itself.

Insulation of Foundation Skirting. As an alternative to insulating the floor, the foundation skirting itself may be insulated. This is commonly done when the floor is close to the ground and the cost to insulate the skirting area is significantly less than insulating the enclosed floor area. Often, insulating the skirting is not practical due to expected degradation of the insulation where it touches the ground or comes into contact with water. The effect of insulating the skirting is to reduce the floor exposure even further, and it is assumed that an insulated skirt will provide a floor exposure factor of 0.3.

Installation of Storm Windows. Storm windows can provide for both reduced infiltration and reduced conduction losses, and they can provide these benefits at a lower cost than replacing the entire window with a double pane unit, although generally their cost is higher for the amount of energy saved than the measures discussed previously. Storm windows are assumed to reduce the total heat losses from the window by 3/4 of the original amount.

B. Analysis of Energy Savings

If the same assumptions and procedures are used for projecting energy savings from conservation measures, the results should not change over time. Thus, the analysis consisted

basically of an independent repeat of previous projections of energy savings and should reach similar results.

The Department of Energy requires that weatherization measures be analyzed and prioritized for each common type of housing involved in the program and each region of the state. Differences between regions of the state may be characterized by average seasonal heating degree days. Georgia may be divided into three regions identified as follows:

Region	Avg. Heating Degree Days
North	3,358
Middle	2,474
South	1,880

The differences between types of houses are significant to the analysis only when there are differences in the existing level of insulation in walls, ceilings, or floors or when their is a difference in the exposure of the floor to air drafts. For this reason, it is not actually necessary to identify the housing types in any great detail.

For this analysis, a baseline house design was selected which included no insulation in the floor, walls, or ceiling, and a fully-exposed floor. Energy savings are projected for each of the conservation measures which might be implemented on this house. In addition, the analysis included incremental savings which could be achieved if floor insulation, partial ceiling insulation, or perimeter skirting were already in place.

An approach was chosen which projects savings from each

measure per square foot of floor area, opaque wall area, or window area. The results may be directly applied to specific houses in order to predict their energy savings. In addition, this method allows for comparisons between projections and actual achievements on houses which have been weatherized. It does introduce a few inconsistencies, however.

While many aspects of space heating loads and weatherization costs are indeed proportional to area, others are not. For example, the cost of installing or insulating foundation skirting should be proportional to perimeter and the height of the floor rather than to floor area. For the few such exceptions, factors were developed which should provide satisfactory results for most common dwelling configurations. These were based on a typical single-level house of 1400 to 1500 ft^2 floor area.

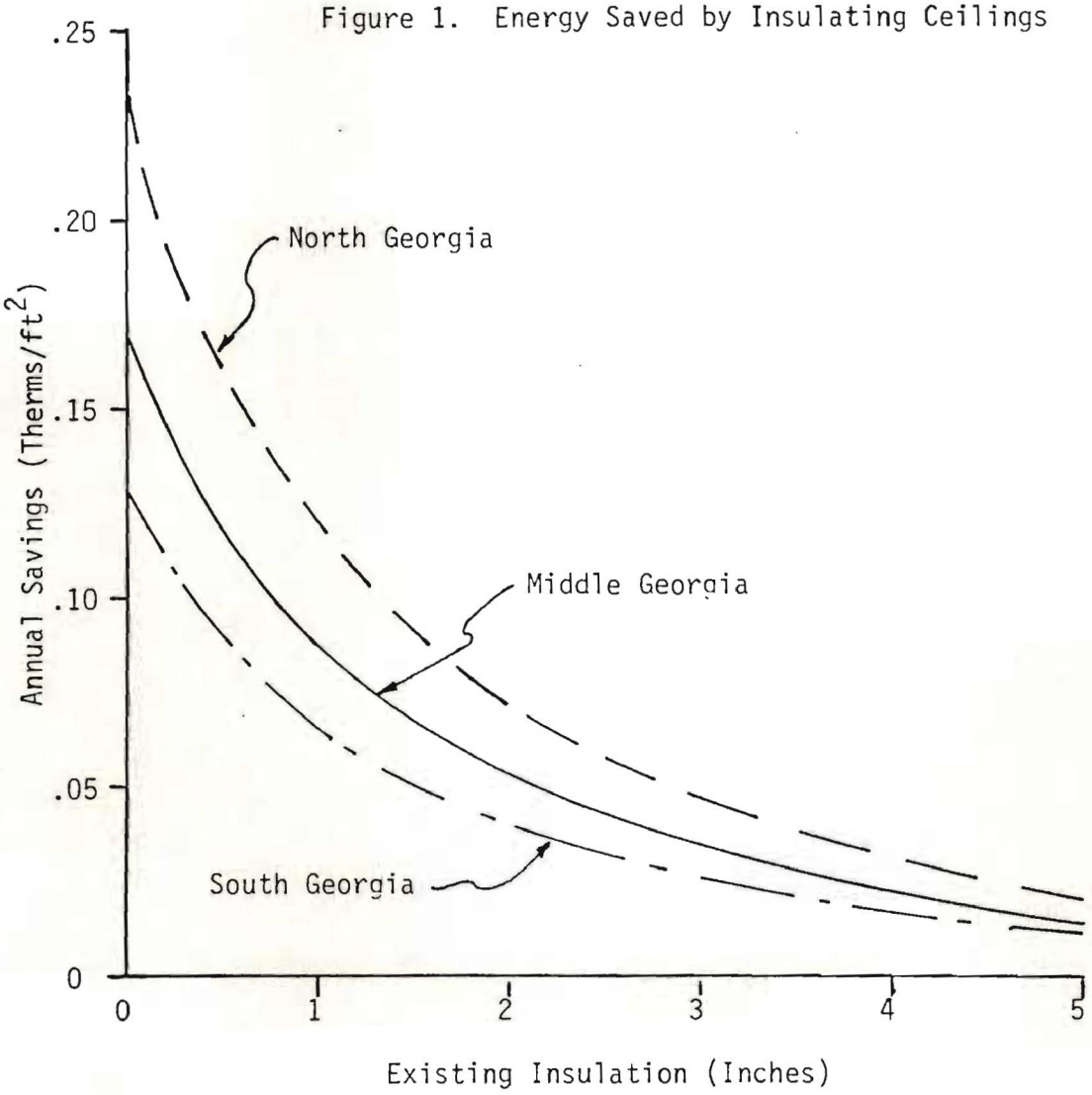
Table 1 presents a summary of the projected energy savings from each of these weatherization measures for each region of Georgia. The savings available by insulating a partially insulated ceiling are dependent upon the amount of insulation which already is installed. This effect is illustrated in Figure 1.

In addition to the weatherization measures which must be prioritized, there are numerous measures categorized as reduction of "general waste of heat." Usually these consist primarily of reducing excess infiltration by repairing broken or loose windows and doors, installing weatherstripping, and caulking cracks and other openings.

Table 1. Projected Energy Savings
(Therms/sq. ft. per year)

Weatherization Measure	Existing Condition	Savings Based on	North Georgia	Middle Georgia	South Georgia
Insulate Attic to R-22	No Insulation (R-3)	Ceiling Area	0.232	0.171	0.130
Insulate Floor to R-22	No Insulation (R-3) No Foundation Skirting	Floor Area	0.232	0.171	0.130
	No Insulation (R-3) Full Foundation Skirting	Floor Area	0.116	0.085	0.065
Install Foundation Skirting	No Floor Insulation	Enclosed Floor Area	0.134	0.099	0.075
	Floor Insulated to R-22	Enclosed Floor Area	0.018	0.013	0.010
Install Both Skirting and Floor Insulation		Floor Area	0.250	0.184	0.140
Insulate Existing Skirting	No Floor Insulation	Enclosed Floor Area	0.054	0.040	0.030
Insulate Walls to R-15	No Insulation (R-3)	Opaque Wall Area	0.215	0.158	0.120
Install Storm Windows	Single Pane Windows	Window Area	0.604	0.445	0.338

Figure 1. Energy Saved by Insulating Ceilings



Notes:

(1) Uninsulated Ceilings are assumed to be R-3.

(2) Existing insulation is assumed to provide R-2.2 per inch.

(3) Final insulation provides R-22 total.

The savings which can be achieved by such measures are dependent on the climate and the extent by which infiltration is reduced. Infiltration is often considered in terms of a "Draft Index," equal to the average number of complete air changes in the house in an hour. Table 2 presents the annual energy savings by reducing the draft index by one air change per hour. Greater reductions will provide proportionate savings. The data are presented for eight and ten foot ceilings for the three regions of the state.

C. Predicted vs. Actual Savings

Data was obtained for thirty-five dwellings which have been weatherized in north Georgia in recent years. These data were used in an attempt to validate the calculated savings and to determine what adjustments should be made, if any.

Twenty-two of the houses had been weatherized with the same combination of measures -- infiltration prevention and ceiling insulation. Since introducing data from the other dwellings would introduce additional statistical uncertainties in attributing savings to individual meaasures, this validation was limited to these two measures and the sub-set of twenty-two dwellings.

Table 3 presents a summary of the predicted and actual energy savings for each of the houses. The "actual" savings are from field records of energy consumption for heating seasons before and after homes were weatherized, with an adjustment for both the

Table 2. Energy Savings From Infiltration Reduction

(Therms/sq. ft. per year)

One air change per hour reduction.

Ceiling Height	North Georgia	Middle Georgia	South Georgia
8 Feet	0.129	0.095	0.072
10 Feet	0.161	0.119	0.090

TABLE 3: Projected and Actual Energy Savings
(Therms/Year)

File Number	Predicted Savings			Actual Savings
	Attic Insulation	Prevent Infiltration	Total	
107	51.1	154.0	205.1	-65.0
111	111.7	127.7	239.4	199.1
114	106.9	205.4	312.3	104.5
128	697.0	388.9	1085.9	-121.7
130	90.8	174.5	265.3	153.1
141	144.2	277.3	421.5	162.5
147	76.9	147.9	224.8	16.3
152	275.9	154.0	429.9	185.3
189	160.3	308.1	468.4	102.3
203	104.1	200.2	304.3	316.1
260	54.6	254.1	308.7	211.5
1013	66.7	128.3	195.0	46.8
1018	338.0	188.7	526.7	256.8
1032	462.2	258.0	720.2	216.3
1043	72.1	138.6	210.7	129.0
1055	227.7	127.1	354.8	60.3
1056	292.7	334.4	627.1	148.0
1057	213.8	119.4	333.2	92.6
1092	109.5	210.4	319.9	413.1
2113	96.2	182.9	279.1	617.9
2182	151.5	291.1	442.6	147.3
2195	265.0	147.9	412.9	230.9

base (summer) fuel consumption level and the variation in the number of heating degree-days for each year.

There is considerable scatter in the data. Two of the units actually consumed more energy after weatherization. On the other hand, three of the units experienced savings which exceeded the theoretical projections, one of them substantially. In general, however, the actual savings were in the range expected -- between zero and the full theoretical value.

There are several reasons for the actual savings to be different from the theoretical value. One of the major sources for discrepancy is the lack of information about the pre-weatherization condition of the house. This has a substantial effect on the theoretical savings from infiltration prevention. The projections in Table 3 have assumed that infiltration has been reduced by one air change per hour.

Other sources for discrepancy generally relate to changes in the utilization of the dwelling and would be very difficult to quantify. Such factors as a different family or number of occupants in the dwelling or, more importantly, a different number of rooms in regular use fall into this category.

The change in utilization which can be understood most readily is an improvement in occupant comfort. Weatherization measures which reduce heat loss can easily result in a higher average winter-time temperature throughout the house rather than resulting exclusively in fuel savings. If such a change in utilization takes place, the program benefits the occupants, but

the benefits are not reflected in the "actual" savings shown in Table 3. This factor is believed to be the primary reason for the fuel savings having a strong tendency to be less than the theoretical values.

A limited statistical analysis of the projected and actual energy savings for the twenty-two houses was performed. The objective of this analysis was to establish an adjustment factor which could be used to convert projected benefits to benefits actually observed as fuel savings. This factor was found to average 49% for the houses for which data were available.

Several considerations must be made if such a factor is to be used in any evaluation of weatherization measures. First, the factor was computed for a specific combination of two weatherization measures and may not be appropriate for other measures and combinations, even though similar changes in utilization are present.

Second, the use of such a factor to indicate effectiveness of a weatherization measure disregards the true value of improvements achieved through weatherization and addresses exclusively the fuel savings. The predicted benefits are energy savings which may be realized through fuel savings, increased comfort, increased utilization of the house, or a combination of these.

Third, the data appear to indicate that this factor tends to be smaller for larger dwellings. This suggests that weatherization measures on small houses result more directly in

fuel savings while on larger houses the benefits are mostly in comfort or other utilization measures. The data and analytical methods employed are not adequate to verify this. Further study on a larger data base using more sophisticated statistical correlation methods is required to prove this hypothesis.

Fourth, the limited extent of the data available on the pre-weatherization condition and usage patterns of the houses may have resulted in substantial errors in predicting the potential benefits.

III. ECONOMIC ANALYSIS

Economic analysis of each candidate weatherization measure serves two purposes:

- It determines whether each measure is economically justified in each region of the state.
- It establishes priorities among the measures to identify where emphasis and effort should be placed if funding is inadequate to implement all of the attractive opportunities.

Three basic factors are necessary to perform the analysis. First, there must be an estimate of all costs associated with implementing the weatherization measures. Since none of the measures is expected to involve recurring costs, this is limited to estimates of labor and material required to install each measure.

Second, there must be a forecast of benefits to be received. This involves the amount of annual benefit, the duration of the benefits, and any change in benefit level over time.

Third, there must be a methodology for the analysis, a basis for establishing economic viability, and a criteria for ranking alternatives.

A. Estimated Costs

Cost information was obtained from the coordinator for two of the contracting agencies -- one in the northern part of the state and one in the south. While the costs were reported for actual

houses or average houses, these were reduced to costs per unit area to correspond to the format for projected energy savings.

In some cases, the data from these sources were insufficient. In these cases, the data used in the analysis conducted in 1980 were used and adjusted for inflation.

The data collected were summarized as average values and are presented in Table 4. The data for insulating attics indicate that there is a base cost for starting the job, with the remainder being proportional to the insulation added. The figures suggest that on average the base labor cost is 20% to 50% of the labor cost to insulate a completely uninsulated attic.

B. Estimated Benefits

Benefits from weatherization may be observed in terms of fuel savings, improved comfort level, or the ability to increase utilization of the dwelling by heating and occupying more rooms. Ideally, all of these benefits may be achieved.

Unfortunately, this presents some difficulty in performing an economic analysis. Normally it is desired to evaluate the benefits in financial terms, and this is difficult with comfort level and improved space utilization. Fuel savings may only be a moderate portion of the total benefits, as discussed in Section II, and the portion is extremely difficult to determine in advance.

For this reason, this economic analysis is based on the value of the total projected heat savings from the weatherization

TABLE 4: Cost of Weatherization Measures

Type of Measure	Material Cost	Labor Cost	Total Cost (1)
Insulation of Uninsulated Attic	12¢/ft^2 (A) 13¢/ft^2 (B)	5¢/ft^2 (A) 4¢/ft^2 (B)	17¢/ft^2
Insulation of Partially Insulated (R-10) Attic	6¢/ft^2 (A)	3¢/ft^2 (A)	9¢/ft^2
Infiltration Prevention	11¢/ft^2 (A) 12¢/ft^2 (B)	9¢/ft^2 (A) 9¢/ft^2 (B)	21¢/ft^2
Insulate Floor R-3 to R-22	21¢/ft^2 (A)(2)	6¢/ft^2 (A) 8¢/ft^2 (B)	28¢/ft^2
Insulate Walls (3)	14¢/ft^2 (B)	8¢/ft^2 (C) 4¢/ft^2 (B)	20¢/ft^2
Install Storm Windows (4)	$2.50/ft^2(B)	$1/ft^2 (B)	$3.50/ft^2
Insulate Existing Skirting	12¢/ft^2 (C)	6¢/ft^2 (C)	18¢/ft^2
Install Skirting	15¢/ft^2 (B)	8¢/ft^2 (B)	23¢/ft^2

Sources of Data Used to Develop These Costs:

(A) Mr. Will Horne, Southeast Energy Technical Group, Atlanta.
(B) Mr. Chandler Monk, Southeast Georgia Community Action Council, Moultrie.
(C) 1980 Retro-Tech evaluation with 6%/yr allowance for inflation.

Notes:

(1) All costs are based on floor area unless noted.
(2) Actual floor insulation cost is 26¢/ft^2 of insulation. This is equivalent to 21¢/ft^2 of floor area.
(3) Based on opaque wall area.
(4) Based on window area.

measures, whether these are reflected in fuel savings or not. This is approximately equivalent to projecting the fuel savings which would be achieved if the same comfort levels and utilization were maintained.

Each of the weatherization measures to be prioritized is expected to be a permanent improvement to the dwelling and have a useful life of up to twenty years without reduction of benefits. On the other hand, many of the measures to reduce infiltration, such as caulking and weatherstripping, will gradually deteriorate and must be repeated periodically. For analysis purposes, these measures are assumed to have an average useful life equivalent to ten years of full benefit.

Of course, none of the weatherization measures can give benefits when the dwelling is not occupied. For this reason, it is essential that the contractors make case-by-case estimates of the useful life of the house and reduce the projected benefits, if appropriate.

The financial benefits of energy savings are dependent upon the energy saved, the price of heating fuel, and the efficiency of the heating unit in converting fuel energy to useful heat. Fuel prices are subject to unpredictable rates of increase. This has led to criticism of many economic analyses which have speculated on future energy costs. As a conservative approach, only current prices of heating fuels are used, with no allowance for inflation.

Table 5 presents current fuel prices in Georgia for common

Table 5. Current Cost of Heating Fuel

Fuel	Price	Energy Cost $ per therm	Avg. Heating Efficiency	Effective Cost of Heat $ per therm
Natural Gas	$ .63/ccf	0.65	0.81	0.80
Fuel Oil	$1.00/gal	0.83	0.83	1.00
Electricity	$ .055/kWh	1.61	0.98	1.65

home heating fuels. This table also presents average heating system efficiencies with these fuels and the resulting cost of useful heat. The efficiencies are based on factors presented in the Project Retro-Tech Job Book.

Efficiency of natural gas fired units can vary considerably depending on the design. Unvented space heaters have a conversion efficiency of near 100%, although their ability to distribute heat throughout a house is quite limited, and this does not include the loss incurred from the high air infiltration rates required to supply fresh air for combustion. On average, however, the figures are perhaps representative of heating costs with the various fuel types. These values, along with the projection of energy savings, provide the basis for determining the economic value of benefits from weatherization.

C. Analysis Method and Results

The weatherization measures are evaluated in terms of the ratio of their benefits to their costs. An opportunity with a ratio greater than 1.0 is economically attractive, while emphasis should be placed on measures with higher ratios, if not all of the attractive measures may be implemented.

The Department of Energy guidelines suggest that benefits be represented as the sum of all benefits derived for the useful life of the measure. This is contrary to established economic analysis principles which recognize that benefits are not as significant if they are delayed in coming. This is called the

"time value of money," and future benefits (and costs) are normally discounted to reflect their present value. The appropriate rate of discounting is frequently a point of disagreement, but a rate of 10% per year is common for government programs.

Since each of the alternatives to be prioritized has a constant rate of benefits over the same useful life, discounting does not affect the rankings. It can, however, have a substantial effect on which measures are judged to be economically attractive. The economic analysis was performed with both discounted and non-discounted benefits so that the results could be compared.

Appendix A includes tables which present the energy savings, dollar values of benefits, payback periods, and benefit/cost ratios for each weatherization measure. Three tables present the results for non-discounted benefits for the three regions of the state, while the other three tables reflect a 10% per year discounting. Each table provides data for natural gas, oil, and electric heating systems.

Two points should be noted in these data. In addition to presenting the findings for the weatherization measures which are to be ranked, the tables present data for the impact of reducing infiltration by one air change per hour. The cost presented for this measure is the average cost for infiltration prevention as reported by the contracting agencies. Since there currently is no basis for stating how much infiltration is reduced in each

house, the benefits presented in the tables may not correspond to the costs presented. Also, since the benefits of insulating a partially insulated ceiling are dependent on the initial insulation, the tables have assumed an initial value of R-10.

Table 6 summarizes the data from Appendix A by listing the priority order of the measures and noting when each is not economically attractive.

Table 6. Priorities For Weatherization Measures

Priority	Weatherization Measure
1	Reduction of General Waste of Heat (Includes infiltration prevention and is ranked #1 per DOE direction.)
2	Insulate uninsulated attic.
3	Insulate walls, when practical.
4	Insulate fully-exposed floors.
5	Install foundation skirting, if installation of floor insulation is not practical.
6	Insulate partially-insulated attic. (Ranking assumes existing ceiling is R-10.
7	Insulate floors, even if there is existing foundation skirting.
8	Insulate foundation skirting, if this is more practical than insulating the floor.
9	Install storm windows.
10	Install foundation skirting, even if floor is fully insulated.

Notes: (1) All measures are economically attractive (benefit/cost ratio > 1.0) except as noted below.

(2) If benefits are discounted at 10% per year, then storm windows are not economically attractive:
   (a) in south Georgia when other than electric heat is used.
   (b) in middle Georgia when natural gas heat is used.

(3) If benefits are discounted at 10% per year, then item #10 is not attractive except in north Georgia when electric heat is used.

(4) Even if benefits are NOT discounted to their present value, item #10 is not attractive:
   (a) in south Georgia when other than electric heat is used.
   (b) in middle Georgia when natural gas heat is used.

IV. ALLOCATION OF PROGRAM FUNDS

A. Indicators of Relative Need

The Department of Energy regulations governing the Weatherization Assistance Program list eight topics which the State's final implementation plan should address for each area of the state to be served by the program. The regulations also indicate that the funds are to be allocated to areas on the basis of the relative need for a weatherization project by low-income persons, taking into account these same eight factors. The factors are as follow:

1. The number of dwelling units to be weatherized.
2. The climatic conditions.
3. The type of weatherization work to be done.
4. The need for weatherization assistance among low-income persons.
5. The amount of energy to be conserved.
6. Mechanisms for providing sources of labor.
7. An estimate of the number of eligible dwelling units in which the elderly reside.
8. An estimate of the number of eligible dwelling units in which the handicapped reside.

The Department of Energy does not indicate how these factors should be quantified for regions of the state or what relative emphasis should be placed on the factors. In addition, this list

is prepared primarily to identify objectives of the implementation plan. As a result, several topics reflect what would be achieved from a given allocation rather than providing a basis for developing the allocation.

Each of the eight topics is discussed below, with emphasis on identifying which are appropriate as factors in a funding allocation formula and how these may be quantified.

Number of Units To Be Weatherized. Rather than being an appropriate factor for determining the allocation, the actual number of units to be weatherized may well be determined by the funds allocated. It is not likely that an accurate count can be made in advance.

Instead, the total number of eligible dwelling units is an appropriate factor for allocating funds, with the available funding determining the actual number of units weatherized. Under this approach, an indicator of the number of eligible dwelling units is required.

Prior to 1970, the Census Bureau collected data on "dilapidated" housing. This classification was found to be too subjective, and the 1970 and 1980 censuses collected data on housing "lacking complete plumbing facilities for exclusive use." While a dwelling's lack of plumbing may not indicate the need for weatherization, the number of dwellings lacking plumbing facilities may well be a good indicator of the number of dwellings in the same region which require weatherization. That is, both are related to the number of sub-standard dwellings in

the area. For this reason, these data are used for the first factor of the formula.

The Climatic Conditions. Thirty-year average data is available from the National Oceanographic and Atmospheric Administration for both heating degree-days and cooling degree-days for nine zones of Georgia. These data reflect the climatic conditions of importance to the program. As would be expected, heating requirements are dominant in the northern part of the state while cooling requirements are dominant in the southern part. When the heating degree-days and cooling degree-days are added, there is less than a 10% variation from the median.

A serious consideration is whether cooling requirements are important to the funding allocation. Under the Weatherization Assistance Program, only very limited measures may be implemented to assist in meeting cooling needs of the dwellings. For this reason, the cooling degree-day data are disregarded in the allocation formula developed.

Weatherization Work To Be Done. For two reasons this factor is not included in the funding allocation formula. First, the types of weatherization measures implemented are determined by economic issues, site specific conditions, and available funding. As with the number of actual dwellings to be weatherized, the weatherization work to be done should be a result rather than a cause of funding allocation. Second, for similar climatic conditions and similar housing, the work to be

done in different areas of the state should be the same. Thus, having both the climatic conditions and the work to be done as factors in the formula should be redundant.

Need for Assistance Among Low-Income Persons. Both income level and poverty status are reflected by Census Bureau data. The Census Bureau summary category which best reflects this topic is the number of families and non-family householders with income below the poverty level.

While these data are available for each county, there is no summary currently available which cross categorizes poverty status with lack of plumbing (need for weatherization) in the dwelling. Although it may reasonably be assumed that poverty status and substandard housing would correlate well, the data to verify this are not currently available to the public. If perfect correlation is assumed, there is no need to include both factors in the formula. If no correlation is assumed, the currently available data are suitable for developing the formula.

The formula developed under this study includes the total number of poverty households in each region. As additional census data are made available to the public, a cross categorization of poverty status with housing quality may be developed and substituted in the formula.

Amount of Energy To Be Conserved. This consideration, again, will correlate to the climatic conditions, the number of dwellings to be weatherized, and the weatherization work to be

done. Including it as a factor in the allocation formula will be redundant.

Mechanisms for Providing Sources of Labor. This item essentially indicates whether an agency is capable of implementing the program effectively. It is not a factor which can be handled in the same manner as the others. Instead, the allocation formula determines relative need in each area without regard for the ability to provide assistance. It then allows the Office of Energy Resources to rate an agency's effectiveness and include this as a factor in determining the agency's share of program funds.

Eligible Dwellings in Which the Elderly Reside. Age is also reflected in the Census Bureau data. If a definition of "elderly" is accepted, the data indicate the number of elderly in each county. The same problem exists, however, in cross categorization of sub-standard housing with age. Such summary data have not yet been released. The funding allocation formula includes a term for total number of persons 65 years of age or over. Again, as additional census data are available to the public, the formula may be modified to reflect the actual number of sub-standard dwellings in which the elderly reside.

Eligible Dwellings in Which the Handicapped Reside. Handicap status is indicated in census data in terms of both work handicaps and transportation handicaps. Work handicaps appear to be more closely related to the interests of the program. Again, the cross categorization of housing condition with handicap

status is not yet available, and an interim formula has been developed. The specific census summary category which is included is the total of non-institutional persons 16 to 64 years of age with a work disability.

In summary, the funding allocation formula is based on five quantitative measures drawn from National Oceanographic and Atmospheric Administration data and several Census Bureau publications:

1. Heating degree-days.
2. Dwelling units lacking complete plumbing facilities for exclusive use (total of owner and renter occupied units).
3. Families and non-family householders with income below the poverty level.
4. Persons 65 years of age and over.
5. Non-institutional persons 16 to 64 years with a work disability.

B. Development of the Allocation Formula

Data were collected for each of these items for each county in Georgia and for the City of Atlanta. Data for Fulton County were recorded excluding the City of Atlanta, to aid in allocating funds between agencies serving the city and the remainder of the county.

These data were used in a micro-computer based program for computation of the funding allocation. The formula which was

developed uses two steps to determine the appropriate funding allocation. First, the relative need for assistance is determined for each county. Second, each agency's share is determined by the total relative need in the counties the agency represents and by the Office of Energy Resources' rating of the agency.

The relative need in a county is computed by an equation of the form:

$$\text{Need} = W_1X_1 + W_2X_2 + \cdots + W_5X_5$$

where X_i = Ratios of quantitative measures of need in the county to the average for all counties

W_i = Weighting factors to reflect relative importance of the five measures

The critical item in this process is selection of proper weighting factors for the five parameters indicating need. Preliminary weighting factors were selected by the Office of Energy Resources as follow:

Units w/o plumbing	0.1
Heating degree-days	0.3
Poverty families	0.4
Population 65 and over	0.1
Handicapped population	0.1

This equation resulted in "County Need Factors" which average 1.00 and which should reflect overall need for assistance from the program. The county factors for counties represented by each agency were summed as an "Agency Factor" to indicate need within

the region served by the agency. Then, a funding share was computed as the ratio of the agency factor to the total of all agency factors, multiplied by the agency rating.

Initially all agencies are rated equally at 1.0. Both the agency ratings and the weighting factors may be adjusted by the Office of Energy Resources, if required, giving revised, equitable funding shares for each agency.

Appendix B presents a listing of the output from the micro-computer program, showing the data for each county, the county need factors, and the agency funding shares based on the weighting factors and agency ratings listed above.

This listing provides a basis for appropriate allocation of program funds to the implementing agencies, while the flexibility of the formula allows for adjustments as additional data are available, as emphasis (weighting) is shifted to other indicators of need, and as specific rating factors for agencies are developed.

Appendix A

Results of Economic Analysis of Weatherization Measures

Weatherization Assistance Program Economic Analysis

Region:	North Georgia	Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	3358	Cost per useful therm ($):	0.80	1.00	1.65
Floor Exposure:	1.00	No Discounting of Future Benefits			

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Non-discounted Payback Period (Years) Gas	Oil	Elect.	Non-discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.232	0.19	0.23	0.38	0.92	0.73	0.44	21.84	27.30	45.04
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.044	0.04	0.04	0.07	2.56	2.05	1.24	7.81	9.76	16.10
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.232	0.19	0.23	0.38	1.51	1.21	0.73	13.26	16.57	27.35
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.215	0.17	0.21	0.35	1.16	0.93	0.56	17.20	21.49	35.46
Install Storm Windows (1 sq ft of window)	3.50	20	0.604	0.48	0.60	1.00	7.24	5.79	3.51	2.76	3.45	5.70
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.134	0.11	0.13	0.22	2.14	1.71	1.04	9.34	11.68	19.27
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.054	0.04	0.05	0.09	4.19	3.35	2.03	4.78	5.97	9.85
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.250	0.20	0.25	0.41	2.55	2.04	1.23	7.85	9.82	16.20
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.129	0.10	0.13	0.21	2.04	1.63	0.99	4.91	6.14	10.13

Weatherization Assistance Program Economic Analysis

Region:	Middle Georgia		Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	2474		Cost per useful therm ($):	0.80	1.00	1.65
Floor Exposure:	1.00		No Discounting of Future Benefits			

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Non-discounted Payback Period (Years) Gas	Oil	Elect.	Non-discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.171	0.14	0.17	0.28	1.24	0.99	0.60	16.09	20.11	33.18
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.032	0.03	0.03	0.05	3.48	2.78	1.69	5.75	7.19	11.87
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.171	0.14	0.17	0.28	2.05	1.64	0.99	9.77	12.21	20.15
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.158	0.13	0.16	0.26	1.58	1.26	0.77	12.67	15.84	26.13
Install Storm Windows (1 sq ft of window)	3.50	20	0.445	0.36	0.45	0.73	9.82	7.86	4.76	2.04	2.54	4.20
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.099	0.08	0.10	0.16	2.91	2.32	1.41	6.88	8.61	14.20
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.040	0.03	0.04	0.07	5.68	4.55	2.76	3.52	4.40	7.26
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.184	0.15	0.18	0.30	3.46	2.77	1.68	5.79	7.23	11.93
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.095	0.08	0.10	0.16	2.76	2.21	1.34	3.62	4.52	7.46

Weatherization Assistance Program Economic Analysis

Region:	South Georgia		Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	1880		Cost per useful therm ($):	0.80	1.00	1.65
Floor Exposure:	1.00		No Discounting of Future Benefits			

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Non-discounted Payback Period (Years) Gas	Oil	Elect.	Non-discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.130	0.10	0.13	0.21	1.64	1.31	0.79	12.23	15.28	25.22
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.025	0.02	0.02	0.04	4.57	3.66	2.22	4.37	5.46	9.02
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.130	0.10	0.13	0.21	2.69	2.16	1.31	7.42	9.28	15.31
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.120	0.10	0.12	0.20	2.08	1.66	1.01	9.63	12.03	19.86
Install Storm Windows (1 sq ft of window)	3.50	20	0.338	0.27	0.34	0.56	12.93	10.34	6.27	1.55	1.93	3.19
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.075	0.06	0.08	0.12	3.82	3.06	1.85	5.23	6.54	10.79
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.030	0.02	0.03	0.05	7.48	5.98	3.63	2.67	3.34	5.51
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.140	0.11	0.14	0.23	4.55	3.64	2.21	4.40	5.50	9.07
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.072	0.06	0.07	0.12	3.64	2.91	1.76	2.75	3.44	5.67

Weatherization Assistance Program Economic Analysis

Region:	North Georgia	Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	3358	Cost per useful therm ($):	0.80	1.00	1.65
Floor Exposure:	1.00	Discount rate per year:	0.10		

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Discounted Payback Period (Years) Gas	Oil	Elect.	Discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.232	0.19	0.23	0.38	1.01	0.80	0.48	9.30	11.62	19.17
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.044	0.04	0.04	0.07	3.10	2.41	1.39	3.32	4.15	6.86
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.232	0.19	0.23	0.38	1.72	1.35	0.80	5.64	7.05	11.64
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.215	0.17	0.21	0.35	1.30	1.02	0.61	7.32	9.15	15.10
Install Storm Windows (1 sq ft of window)	3.50	20	0.604	0.48	0.60	1.00	13.50	9.08	4.53	1.18	1.47	2.43
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.134	0.11	0.13	0.22	2.53	1.97	1.15	3.98	4.97	8.20
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.054	0.04	0.05	0.09	5.69	4.28	2.38	2.03	2.54	4.19
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.250	0.20	0.25	0.41	3.08	2.39	1.38	3.34	4.18	6.89
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.129	0.10	0.13	0.21	2.39	1.87	1.09	3.02	3.77	6.23

Weatherization Assistance Program Economic Analysis

Region:	Middle Georgia		Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	2474		Cost per useful therm ($):	0.80	1.00	1.65
Floor Exposure:	1.00		Discount rate per year:	0.10		

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Discounted Payback Period (Years) Gas	Oil	Elect.	Discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.171	0.14	0.17	0.28	1.39	1.10	0.65	6.85	8.56	14.13
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.032	0.03	0.03	0.05	4.48	3.42	1.94	2.45	3.06	5.05
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.171	0.14	0.17	0.28	2.40	1.88	1.10	4.16	5.20	8.58
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.158	0.13	0.16	0.26	1.80	1.42	0.84	5.39	6.74	11.12
Install Storm Windows (1 sq ft of window)	3.50	20	0.445	0.36	0.45	0.73	42.41	16.17	6.79	0.87	1.08	1.79
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.099	0.08	0.10	0.16	3.60	2.78	1.59	2.93	3.66	6.04
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.040	0.03	0.04	0.07	8.82	6.36	3.38	1.50	1.87	3.09
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.184	0.15	0.18	0.30	4.45	3.40	1.92	2.46	3.08	5.08
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.095	0.08	0.10	0.16	3.39	2.62	1.51	2.22	2.78	4.59

Weatherization Assistance Program Economic Analysis

Region:	South Georgia		Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	1880		Cost per useful therm ($):	0.80	1.00	1.65
Floor Exposure:	1.00		Discount rate per year:	0.10		

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Discounted Payback Period (Years) Gas	Oil	Elect.	Discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.130	0.10	0.13	0.21	1.87	1.47	0.87	5.20	6.51	10.73
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.025	0.02	0.02	0.04	6.42	4.78	2.63	1.86	2.33	3.84
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.130	0.10	0.13	0.21	3.29	2.55	1.47	3.16	3.95	6.52
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.120	0.10	0.12	0.20	2.44	1.91	1.11	4.10	5.12	8.45
Install Storm Windows (1 sq ft of window)	3.50	20	0.338	0.27	0.34	0.56	Inf.	Inf.	10.34	0.66	0.82	1.36
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.075	0.06	0.08	0.12	5.05	3.83	2.15	2.23	2.78	4.59
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.030	0.02	0.03	0.05	14.46	9.57	4.73	1.14	1.42	2.35
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.140	0.11	0.14	0.23	6.37	4.75	2.61	1.87	2.34	3.86
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.072	0.06	0.07	0.12	4.74	3.61	2.03	1.69	2.11	3.49

Appendix B

Funding Allocation Formula Sample Printout

WEATHERIZATION ASSISTANCE PROGRAM
Funding Allocation Formula

	Units w/o Plumbing	Heating Deg-Days	Poverty Families	Pop. Over 65	Handicap. Pop.	
Wt. Factor-)	0.10	0.30	0.40	0.10	0.10	
Norm -)	372	2522	2003	3059	2253	
County						County Factor
Appling	219	1778	1434	1537	1405	0.66936
Atkinson	211	1932	632	673	623	0.46245
Bacon	53	1778	844	970	798	0.46144
Baker	83	1932	386	484	341	0.36021
Baldwin	328	2471	1540	2731	2221	0.87754
Banks	229	3284	440	1003	741	0.60583
Barrow	343	3422	1361	2347	1646	0.92091
Bartow	608	3368	2100	3857	3167	1.25017
Ben Hill	173	1932	1520	2047	1219	0.70090
Berrien	128	1932	989	1525	1064	0.55883
Bibb	630	2471	10290	15209	12021	3.54869
Bleckley	279	2471	690	1191	828	0.58248
Brantley	98	1778	574	801	689	0.40927
Brooks	515	1932	1546	2033	1158	0.79491
Bryan	208	1778	666	755	813	0.46122
Bulloch	695	2306	2541	3265	2541	1.18814
Burke	793	2306	1786	2137	1590	0.98466
Butts	339	2471	662	1345	1051	0.60795
Calhoun	242	1932	569	810	385	0.45212
Camden	224	1778	960	1065	965	0.54111
Candler	181	2306	682	1032	646	0.52162
Carroll	760	2646	3291	5571	4145	1.54239
Catoosa	168	3368	1745	3076	2563	1.00861
Charlton	189	1778	476	681	583	0.40555
Chatham	709	1778	12873	20240	12546	4.19100
Chattahoochee	63	2646	334	191	813	0.44077
Chatooga	319	3368	1428	2617	2111	0.95087
Cherokee	455	3422	1983	3858	2914	1.18089
Clarke	336	3422	6034	5516	3433	2.03498
Clay	228	1932	437	548	274	0.40851
Clayton	362	2646	4064	6194	7955	1.77914
Clinch	237	1932	571	609	487	0.44913
Cobb	653	3422	7232	15642	14736	3.19208
Coffee	340	1932	2175	2642	2545	0.95490
Colquitt	381	1932	2553	4216	2963	1.11140
Columbia	378	2306	1527	1982	2435	0.85377
Cook	167	1932	897	1549	973	0.54770
Coweta	650	2646	2422	4153	2974	1.24097

Crawford	333	2471	494	707	559	0.53010
Crisp	219	1932	1776	2242	1259	0.77254
Dade	198	3368	782	999	986	0.68652
Dawson	71	3422	345	504	352	0.52721
Decatur	599	1932	1856	2974	1905	0.94331
DeKalb	961	3422	16385	32269	22816	6.00462
Dodge	393	2471	1757	2082	1610	0.89002
Dooly	295	1932	1169	1402	942	0.63025
Dougherty	523	1932	6335	6872	5752	2.11534
Douglas	238	2646	1484	3219	3098	0.91784
Early	446	1932	1269	1688	906	0.69858
Echols	62	1932	204	261	207	0.30499
Effingham	358	2306	1027	1531	1347	0.68553
Elbert	488	3284	1418	2353	1333	0.94117
Emanual	581	2306	1825	2433	1840	0.95621
Evans	187	1778	746	1017	660	0.47332
Fannin	347	3422	1415	2123	1458	0.91710
Fayette	220	2646	623	1764	1284	0.61302
Floyd	543	3368	4071	8932	5627	1.90131
Forsyth	265	3422	1180	2300	1745	0.86664
Franklin	223	3284	1258	1987	1254	0.82248
Fulton (ex Atl)	648	3422	3844	11879	6122	2.00896
Atlanta	2168	3422	41458	47481	30004	12.15184
Gilmer	299	3422	936	1369	1203	0.77258
Glascock	70	2306	189	328	213	0.35110
Glynn	236	1778	3186	5871	4031	1.28197
Gordon	351	3368	1629	2862	2080	1.00624
Grady	404	1932	1743	2550	1540	0.83824
Greene	540	2471	995	1598	920	0.73096
Gwinnett	649	3422	3618	8117	7199	1.88892
Habersham	303	3284	1436	2614	2043	0.93505
Hall	659	3422	3390	7171	5584	1.74349
Hancock	577	2471	987	1089	738	0.71460
Haralson	280	2646	1170	2100	1472	0.75770
Harris	602	2646	1019	1826	1122	0.78966
Hart	325	3284	1236	2201	1500	0.86343
Heard	237	2646	412	766	621	0.51341
Henry	511	2646	1381	3044	2234	0.92664
Houston	420	2471	2839	3841	5505	1.34368
Irwin	181	1932	702	1196	592	0.48408
Jackson	400	3422	1405	2714	2048	0.97486
Jasper	258	2471	577	991	458	0.53131
Jeff Davis	196	1932	726	1138	1001	0.50916
Jefferson	688	2306	1840	2317	1275	0.95911
Jenkins	353	2306	925	994	948	0.62856
Johnson	333	2471	784	1109	725	0.60852
Jones	314	2471	793	1230	1110	0.62625
Lamar	267	2646	719	1440	938	0.61888
Lanier	97	1932	494	639	484	0.39695
Laurens	806	2471	2667	4085	3052	1.31226
Lee	167	1932	594	763	482	0.43971
Liberty	398	1778	1904	1249	2067	0.83131

Lincoln	230	3284	418	807	522	0.58558
Long	105	1778	343	386	367	0.33717
Lowndes	566	1932	4558	5583	4174	1.65993
Lumpkin	190	3422	645	946	798	0.65336
McDuffie	451	2306	1394	1740	1469	0.79607
McIntosh	226	1778	831	898	842	0.50497
Macon	433	2646	1355	1571	1073	0.80079
Madison	277	3284	1086	1758	1299	0.79717
Marion	310	2646	538	607	505	0.54786
Meriwether	822	2646	1555	2533	1419	0.99215
Miller	159	1932	657	927	448	0.45399
Mitchell	361	1932	1818	2279	1505	0.83124
Monroe	471	2471	749	1531	1061	0.66735
Montgomery	177	2471	506	845	557	0.49497
Morgan	305	2471	747	1400	659	0.60018
Murray	309	3368	1010	1518	1412	0.79777
Muscogee	454	2646	11054	14280	12050	3.64564
Newton	701	2471	1709	3377	1977	1.02189
Oconee	183	3422	554	1075	728	0.63442
Oglethorpe	359	3284	576	1062	636	0.66522
Paulding	358	3368	1381	2302	2012	0.93728
Peach	363	2471	1523	1586	1528	0.81537
Pickens	421	3422	779	1442	1009	0.76782
Pierce	169	1778	977	1263	1142	0.54404
Pike	234	2646	409	1005	599	0.51884
Polk	451	3368	2179	3971	3016	1.22075
Pulaski	202	2471	813	1145	716	0.57985
Putnam	229	2471	730	1106	731	0.56993
Quitman	168	1932	293	339	214	0.35413
Rabun	199	3284	803	1463	968	0.69536
Randolph	493	1932	1080	1471	675	0.65614
Richmond	660	2306	11221	14397	11550	3.67558
Rockdale	171	2471	1029	2410	1804	0.70428
Schley	122	2646	326	426	245	0.43751
Screven	516	2306	1564	1730	1186	0.83461
Seminole	185	1932	759	1134	664	0.49770
Spalding	423	2646	2923	4915	3502	1.32830
Stephens	261	3284	1372	2600	1694	0.89503
Stewart	357	1932	725	833	566	0.52298
Sumter	804	1932	2195	3111	2010	1.07527
Talbot	478	2646	459	863	513	0.58599
Taliaferro	149	2471	243	426	209	0.40578
Tattnall	259	1778	1640	1977	1469	0.73848
Taylor	291	2646	626	1028	650	0.58052
Telfair	272	1932	1041	1544	1091	0.60976
Terrell	521	1932	1142	1519	710	0.67917
Thomas	605	1932	2721	4331	2749	1.19946
Tift	435	1932	2401	3102	2490	1.03817
Toombs	322	1778	2042	2205	2191	0.87518
Towns	73	3284	518	921	448	0.56377
Treutlen	219	2471	550	808	676	0.51912
Troup	1080	2646	3456	6314	3799	1.67033

Turner	210	1932	886	1092	732	0.53143
Twiggs	425	2471	584	884	589	0.57994
Union	207	3422	967	1376	876	0.73974
Upson	679	2646	1381	3483	2202	0.98475
Walker	430	3368	2942	5903	4281	1.48674
Walton	541	3422	1828	3138	2331	1.12366
Ware	392	1778	2728	4010	3441	1.14546
Warren	280	2306	623	884	498	0.52506
Washington	962	2471	1613	2250	1468	1.01349
Wayne	254	1778	1439	2037	1908	0.71844
Webster	133	1932	224	285	180	0.32766
Wheeler	135	2471	548	734	561	0.48861
White	170	3422	738	1207	764	0.67357
Whitfield	425	3368	3013	5367	4499	1.49173
Wilcox	180	1932	797	1029	617	0.49843
Wilkes	333	3284	955	1546	774	0.75585
Wilkinson	407	2471	629	1126	730	0.59825
Worth	488	1932	1341	1939	1143	0.74298
					Sum:	160.00000

Agency	Total of County Factors	Agency Rating	Agency Factor	Funding Share
1 Albany Urban League Albany, GA (Dougherty)	2.115	1.000	2.115	0.014261
2 Altamaha Area CAA, Inc. Reidsville, GA (Appling, Bulloch, Candler, Evans Jeff Davis, Tattnall, Toombs, Wayne)	5.694	1.000	5.694	0.038385
3 ACTION, Inc. Athens, GA (Barrow, Clarke, Elbert, Greene, Madison, Morgan, Oglethorpe, Walton)	7.814	1.000	7.814	0.052682
4 Central Savannah River Area EOA, Inc. Augusta, GA (Burke, Columbia, Emanuel, Glascock, Jefferson, Jenkins, Lincoln, McDuffie, Richmond, Screven, Taliaferro, Wilkes)	11.787	1.000	11.787	0.079464

5	Clayton Co. CSA, Inc. Forrest Park, GA (Clayton, Fayette, Henry)	3.319	1.000	3.319	0.022374
6	Coastal Georgia Area CAA, Inc. Brunswick, GA (Bryan, Camden, Glynn, Liberty, Long, McIntosh)	3.958	1.000	3.958	0.026682
7	Coastal Plain Area EOA, Inc. Valdosta, GA (Ben Hill, Brooks, Echols, Irwin, Lanier, Lowndes, Tift, Turner)	5.911	1.000	5.911	0.039853
8	Community Action for Improvement, Inc. LaGrange, GA (Carroll, Coweta, Heard, Merriwether, Troup)	5.959	1.000	5.959	0.040176
9	DeKalb County EOA, Inc. Decatur, GA (DeKalb)	6.005	1.000	6.005	0.040482
10	Economic Opportunity Atlanta, Inc. Atlanta, GA (Douglas, Fulton, Gwynnett, Rockdale)	5.520	1.000	5.520	0.037214
11	EOA for Savannah-Chatham County Areas Savannah, GA (Chatham)	4.191	1.000	4.191	0.028255
12	Enrichment Services Program, Inc. Columbus, GA (Chattahoochee, Clay, Harris, Muscogee, Quitman, Randolph, Stewart, Talbot)	7.404	1.000	7.404	0.049915
13	Heart of Georgia CAA, Inc. Eastman, GA (Bleckley, Dodge, Laurens, Montgomery, Pulaski, Telfair, Treutlen, Wheeler, Wilcox)	5.975	1.000	5.975	0.040285
14	Macon-Bibb County EOC Macon, GA (Bibb, Jones, Lamar)	4.794	1.000	4.794	0.032319
15	Marietta/Cobb CSC Marietta, GA (Cobb)	3.192	1.000	3.192	0.021520

16	Middle Georgia CAA, Inc. Warner Robins, GA (Houston, Monroe, Peach, Twiggs)	3.406	1.000	3.406	0.022965
17	Migrant and Seasonal Farmworkers Assoc. Waycross, GA (Ware[40%])	0.458	1.000	0.458	0.003089
18	Ninth District Opportunity, Inc. Gainesville, GA (Banks, Dawson, Forsyth, Franklin, Habersham, Hart, Lumpkin, Rabun, Stephens, Towns, Union, White)	8.841	1.000	8.841	0.059607
19	North Georgia CAA, Inc. Jasper, GA (Cherokee, Fannin, Gilmer, Murray, Pickens, Whitfield)	5.928	1.000	5.928	0.039964
20	Northwest Georgia EOA, Inc. LaFayette, GA (Chattooga, Dade, Walker)	3.124	1.000	3.124	0.021062
21	Overview Corporation Milledgeville, GA (Baldwin, Hancock, Jasper, Johnson, Putnam, Washington, Wilkinson)	4.914	1.000	4.914	0.033126
22	Slash Pine CAA, Inc. Waycross, GA (Atkinson, Bacon, Brantley, Charlton Clinch, Coffee, Pierce, Ware[60%])	4.374	1.000	4.374	0.029489
23	Southeast Energy Technical Group Atlanta, GA (City of Atlanta)	12.152	1.000	12.152	0.081925
24	Southeast Georgia CAC, Inc. Moultrie, GA (Baker, Calhoun, Colquitt, Decatur, Early, Grady, Lee, Miller, Mitchell, Seminole, Terrell, Thomas, Worth)	9.248	1.000	9.248	0.062348

25	Tallatoona EOA, Inc. Cartersville, GA (Bartow, Floyd, Gordon, Haralson, Paulding, Polk)	7.073	1.000	7.073	0.047687
26	West Central Georgia CAC, Inc. Montezuma, GA (Crisp, Dooley, Macon, Marion Schley, Sumter, Taylor, Webster)	5.172	1.000	5.172	0.034871
	Sub-total:	148.330		148.330	1.000000
	No Agency:	11.670			
	Total:	160.000			

A-3606

FINAL REPORT
PROJECT A-3606

WEATHERIZATION ASSISTANCE PROGRAM ANALYSIS

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Project Director

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Prepared for:

GEORGIA OFFICE OF ENERGY RESOURCES
ATLANTA, GEORGIA

January 1984

GEORGIA INSTITUTE OF TECHNOLOGY
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Engineering Experiment Station
Atlanta, Georgia 30332

1984

Project No. A-3606

WEATHERIZATION ASSISTANCE PROGRAM ANALYSIS

Final Report

Submitted to:

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I. INTRODUCTION

The dramatic increases in home heating fuel prices have placed a serious financial burden on economically-disadvantaged families. The Weatherization Assistance Program, funded by the U.S. Department of Energy, provides State Energy Offices with a means to assist these families to improve the energy effectiveness of their homes. Through this program, various common energy conservation measures are implemented to reduce unnecessary heat losses.

When fuel prices are low, incentives exist which discourage investment in energy conserving construction. This is true for all economic levels of society. As fuel prices rise, the incentives change, and many weatherization measures can be justified economically for existing houses.

Unfortunately, the economically-disadvantaged often do not have the capital resources available to implement these measures. Since they are not able to take effective steps to offset rising fuel prices, these people begin to assume a disproportionate share of the national fuel bill and may be forced into seriously reduced standards of living.

The basic role of the Weatherization Assistance Program is to permit disadvantaged households to implement the same conservation measures as are justifiable for those who are more financially able.

The Georgia Office of Energy Resources implements this

program through twenty-six contractors who provide the materials and labor for the weatherization efforts, as well as local management of the program. These contracting agencies cover all but thirteen of the 159 counties of the state.

Two particular questions have arisen in the implementation of the program. First, are the guidelines provided to the agencies by the Office of Energy Resources up-to-date in their recommendations on which weatherization measures to implement? These guidelines address both which weatherization measures are economically justified and which should receive priority attention if funds are inadequate to implement all justifiable measures. Such guidelines can become outdated as material, labor, and fuel costs change.

Second, are the State's funds for the program being allocated to the various agencies equitably? The Department of Energy has identified general topics to be addressed in allocating funds to areas of the state, but a quantitative method is not presented, and the principles being used by Georgia have not been well documented.

This report presents the findings from a study conducted by the Georgia Institute of Technology to assist the Georgia Office of Energy Resources in addressing these two concerns. Section II discusses various common home weatherization measures and the projected benefits from each. Section III discusses the costs and economics of these measures and suggests priorities by types of houses and regions of the state. Section IV presents a

quantitative method for determining relative need for assistance in each area and the share of program funding which should be allocated to each contracting agency.

II. PROJECTED BENEFITS FROM WEATHERIZATION MEASURES

The original Project Retro-Tech Job Book required each candidate dwelling for weatherization assistance to be analyzed individually and a priority list of weatherization measures to be developed. Because of difficulties encountered by project contractors in performing these analyses and the similarity of results which were obtained for similar structures, the procedure was altered to allow for predetermination of priorities for various measures on a state level.

This new system is already in operation in Georgia, and the current analysis is intended as an updating of the priorities which were established previously. Several factors have led to the need for such updating:

- Changes in the cost of energy.
- Changes in material and labor costs and the availability of additional information on these costs.
- A desire to review the established procedures to assure their accuracy.

There are two steps in conducting the analyses. The first step is to project the energy to be saved by each weatherization measure. The second is to determine the current and projected financial costs and savings from each measure and rank the measures according to their benefit/cost ratio.

This section of this report addresses the first step and

discusses common weatherization measures, characteristics of existing dwellings which affect the potential benefits from weatherization, projections of these benefits for various houses and regions of the state, and a comparison of projected benefits and actual fuel savings for a limited sample of dwellings which have been weatherized.

A. Weatherization Measures

The Department of Energy guidelines, as presented in the Project Retro-Tech Job Book, identify five categories of heat loss for which conservation measures must be analyzed and prioritized by the State:

1. Heat loss by conduction through uninsulated ceilings.
2. Heat loss by conduction through partially insulated ceilings.
3. Heat losses by conduction through floors.
4. Heat losses by conduction through uninsulated walls.
5. Heat losses by conduction and infiltration through single pane glass windows.

Common conservation measures which address these heat losses include added insulation in ceilings/roofs, floors, and walls; installation and insulation of foundation skirting; and installation of storm windows. Each of these measures are discussed below, and many of the assumptions presented are based on the Project Retro-Tech Job Book.

Ceiling Insulation. Heat loss by conduction through uninsulated ceilings and roofs can be appreciable. Corrective measures involve addition of suitable insulating materials in a manner appropriate to the style and condition of the dwelling. The most common method is the use of blown, loose-fill fiberglass insulation between and over the ceiling joists in the attic area. In some dwellings this is not practical due to the design (lack of or inaccessibility of space above ceiling), while in others it is inappropriate because of the inadequacy of the ceiling materials to support the added weight. In such instances, other approaches to increasing the thermal resistance of the ceiling/roof must be taken.

The thermal resistance is specified in terms of "R-value," defined in units [hr ft^2 ^oF per Btu]. Typical uninsulated ceilings have an R-value of 3, while the analyses in this report have assumed a fully-insulated ceiling to have a thermal resistance of R-22, suitable for most areas of Georgia. Ceilings have often been insulated to a lesser degree. Improving partially-insulated ceilings can also be cost effective, although the benefit per dollar invested is less than is achieved on completely uninsulated ceilings.

Floor Insulation. Insulation of floors is appropriate when the foundation design exposes the floor to winter winds. Fiberglass batt insulation is usually installed between the floor joists and supported by spring wires. The analysis of potential benefits assumes that the uninsulated floor has an effective

thermal resistance of R-3 and that this will be increased to R-22.

It should be noted that while insulating floors will reduce home heating costs, there is an offsetting consideration. Water pipes located in crawl spaces will be exposed to colder winter temperatures after the floor is insulated and may be more prone to burst due to freezing. As a part of the floor insulation job, the contractor should assess the probability of damage due to freezing and insulate the pipes if necessary.

Installation of Foundation Skirting. A skirting around the foundation of the house can reduce the heat loss through the floor by reducing the exposure of the floor to ambient air flow. The analysis of potential benefits assumes that the exposure factor is reduced from 1.0 to 0.5 by the installation of skirting. Both floor insulation and perimeter skirting may be installed to reduce these heat losses. The two may be installed on the same house, but the benefits will be less than the sum of the benefits from performing the measures individually. Since the combination can still be cost effective, this is analyzed as a weatherization measure in itself.

Insulation of Foundation Skirting. As an alternative to insulating the floor, the foundation skirting itself may be insulated. This is commonly done when the floor is close to the ground and the cost to insulate the skirting area is significantly less than insulating the enclosed floor area. Often, insulating the skirting is not practical due to expected

degradation of the insulation where it touches the ground or comes into contact with water. The effect of insulating the skirting is to reduce the floor exposure even further, and it is assumed that an insulated skirt will provide a floor exposure factor of 0.3.

Wall Insulation. In many cases, the insulation of existing walls may be an extremely difficult task. Whether it is appropriate in a specific dwelling is influenced more by the barriers to performing the job than by the economics. The analyses in this report assume that the contractor, with guidance from the Office of Energy Resources, will undertake wall insulation only when it is truly a practical weatherization measure.

In cases where wall insulation may be added, the most common method is blowing fiberglass insulation into the cavity behind the wall in houses constructed with stud walls. Such procedures may increase the thermal resistance of the wall from approximately R-3 to R-15. Higher R-values cannot normally be achieved due to space limitations inside standard walls.

Installation of Storm Windows. Storm windows can provide for both reduced infiltration and reduced conduction losses, and they can provide these benefits at a lower cost than replacing the entire window with a double pane unit, although generally their cost is higher for the amount of energy saved than the measures discussed previously. Storm windows are assumed to reduce the total heat losses from the window by 3/4 of the

original amount.

B. Analysis of Energy Savings

If the same assumptions and procedures are used for projecting energy savings from conservation measures, the results should not change over time. Thus, the analysis consisted basically of an independent repeat of previous projections of energy savings and should reach similar results.

The Department of Energy requires that weatherization measures be analyzed and prioritized for each common type of housing involved in the program and each region of the state. Differences between regions of the state may be characterized by average seasonal heating degree days. Georgia may be divided into three regions identified as follows:

Region	Avg. Heating Degree Days
North	3,358
Middle	2,474
South	1,880

The differences between types of houses are significant to the analysis only when there are differences in the existing level of insulation in walls, ceilings, or floors or when there is a difference in the exposure of the floor to air drafts. For this reason, it is not actually necessary to identify the housing types in any great detail.

For this analysis, a baseline house design was selected which included no insulation in the floor, walls, or ceiling, and a

fully-exposed floor. Energy savings are projected for each of the conservation measures which might be implemented on this house. In addition, the analysis included incremental savings which could be achieved if floor insulation, partial ceiling insulation, or perimeter skirting were already in place.

An approach was chosen which projects savings from each measure per square foot of floor area (equal to ceiling area), opaque wall area, or window area. The results may be directly applied to specific houses in order to predict their energy savings. In addition, this method allows for comparisons between projections and actual achievements on houses which have been weatherized. It does introduce a few inconsistencies, however.

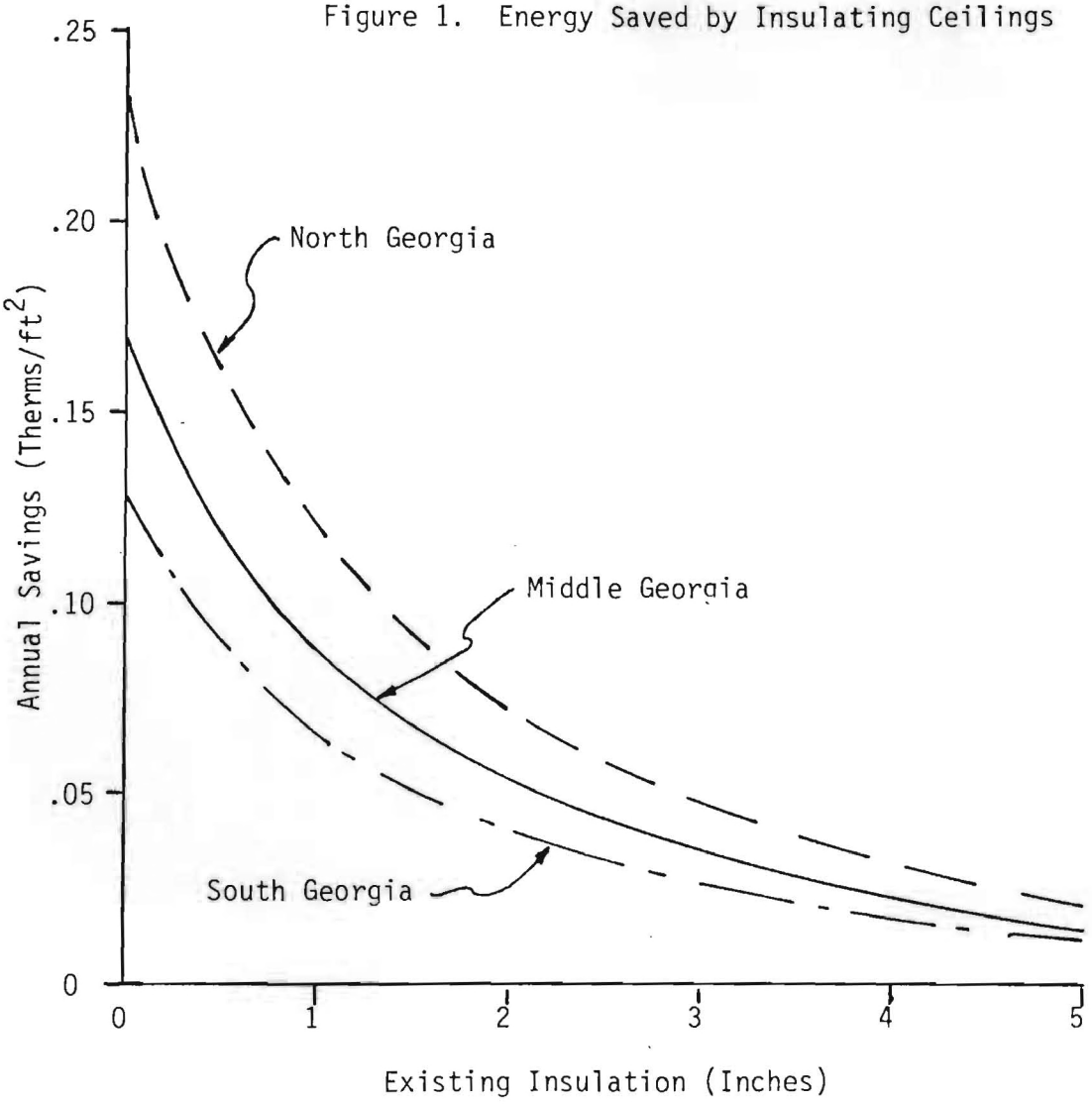
While many aspects of space heating loads and weatherization costs are indeed proportional to area, others are not. For example, the cost of installing or insulating foundation skirting should be proportional to perimeter and the height of the floor rather than to floor area. For the few such exceptions, factors were developed which should provide satisfactory results for most common dwelling configurations. These were based on a typical single-level house of 1400 to 1500 ft^2 floor area.

Table 1 presents a summary of the projected energy savings from each of these weatherization measures for each region of Georgia. The savings available by insulating a partially insulated ceiling are dependent upon the amount of insulation which already is installed. This effect is illustrated in Figure 1.

Table 1. Projected Energy Savings
(Therms/sq. ft. per year)

Weatherization Measure	Existing Condition	Savings Based on	North Georgia	Middle Georgia	South Georgia
Insulate Attic to R-22	No Insulation (R-3)	Ceiling Area	0.232	0.171	0.130
Insulate Floor to R-22	No Insulation (R-3) No Foundation Skirting	Floor Area	0.232	0.171	0.130
	No Insulation (R-3) Full Foundation Skirting	Floor Area	0.116	0.085	0.065
Install Foundation Skirting	No Floor Insulation	Enclosed Floor Area	0.134	0.099	0.075
	Floor Insulated to R-22	Enclosed Floor Area	0.018	0.013	0.010
Install Both Skirting and Floor Insulation		Floor Area	0.250	0.184	0.140
Insulate Existing Skirting	No Floor Insulation	Enclosed Floor Area	0.054	0.040	0.030
Insulate Walls to R-15	No Insulation (R-3)	Opaque Wall Area	0.215	0.158	0.120
Install Storm Windows	Single Pane Windows	Window Area	0.604	0.445	0.338

Figure 1. Energy Saved by Insulating Ceilings



Notes:

(1) Uninsulated Ceilings are assumed to be R-3.

(2) Existing insulation is assumed to provide R-2.2 per inch.

(3) Final insulation provides R-22 total.

In addition to the weatherization measures which must be prioritized, there are numerous measures categorized as reduction of "general waste of heat." Usually these consist primarily of reducing excess infiltration by repairing broken or loose windows and doors, installing weatherstripping, and caulking cracks and other openings. The savings which can be achieved by such measures are dependent on the climate and the extent by which infiltration is reduced. Infiltration is often considered in terms of a "Draft Index," equal to the average number of complete air changes in the house in an hour. Table 2 presents the annual energy savings by reducing the draft index by one air change per hour. Greater reductions will provide proportionate savings. The data are presented for eight and ten foot ceilings for the three regions of the state.

C. Predicted vs. Actual Savings

Data was obtained for thirty-five dwellings which were weatherized in north Georgia in 1982. These data were used in an attempt to validate the calculated savings and to determine what adjustments should be made, if any.

Twenty-two of the houses had been weatherized with the same combination of measures -- infiltration prevention and ceiling insulation. Since introducing data from the other dwellings would introduce additional statistical uncertainties in attributing savings to individual measures, this validation was limited to these two measures and these twenty-two dwellings.

Table 2. Energy Savings From Infiltration Reduction

(Therms/sq. ft. per year)

One air change per hour reduction.

Ceiling Height	North Georgia	Middle Georgia	South Georgia
8 Feet	0.129	0.095	0.072
10 Feet	0.161	0.119	0.090

Table 3 presents a summary of the predicted and actual energy savings for each of the houses. The "actual" savings are from field records of energy consumption for heating seasons before and after homes were weatherized, with an adjustment for both the base (summer) fuel consumption level and the variation in the number of heating degree-days for each year. That is, the average gas consumption in the summer was subtracted from the monthly gas consumption in the winter to determine the heating load. This total of this load over the heating season was then multiplied by the ratio of the average number of heating degree-days (3358) to the actual heating degree-days (3139 in 1981-82 and 2998 in 1982-83), giving the heating consumption adjusted to an average year. The difference between the adjusted consumption levels for the two years is the "actual" savings shown in the table.

There is considerable scatter in the data. Three of the units (File No. 107, 128, and 141) actually consumed more energy after weatherization. On the other hand, three of the units (File No. 203, 1092, and 2113) experienced savings which exceeded the theoretical projections, one of them substantially. In general, however, the actual savings were in the range expected -- between zero and the full theoretical value.

There are several reasons for the actual savings to be different from the theoretical value. One of the major sources for discrepancy is the lack of information about the pre-weatherization condition of the house. This has a

Table 3. Projected and Actual Energy Savings
(Therms/Year)

File No.	Projected Savings			Actual Savings	Percent of Proj.
	Attic Insul.	Prevent Infil.	Total		
107	51.1	154.0	205.1	-80.1	-39.1
111	111.7	127.7	239.4	228.5	95.4
114	106.9	205.4	312.3	120.0	38.4
128	697.0	388.9	1085.9	-126.4	-11.6
130	90.8	174.5	265.3	183.8	69.3
141	144.2	277.3	421.5	-31.8	-7.5
147	76.9	147.9	224.8	25.6	11.4
152	275.9	154.0	429.9	209.5	48.7
189	160.3	308.1	468.4	125.2	26.7
203	104.1	200.2	304.3	368.5	121.1
260	54.6	254.1	308.7	231.4	75.0
1013	66.7	128.3	195.0	53.7	27.6
1018	338.0	188.7	526.7	292.3	55.5
1032	462.2	258.0	720.2	244.2	33.9
1043	72.1	138.6	210.7	141.5	67.1
1055	227.7	127.1	354.8	66.9	18.8
1056	292.7	334.4	627.1	175.2	27.9
1057	213.8	119.4	333.2	117.5	35.3
1092	109.5	210.4	319.9	470.0	146.9
2113	96.2	182.9	279.1	703.9	252.2
2182	151.5	291.1	442.6	218.2	49.3
2195	265.0	147.9	412.9	267.1	64.7
				Average =	54.9

substantial effect on the theoretical savings from infiltration prevention. The projections in Table 3 have assumed that infiltration has been reduced by one air change per hour.

Other sources for discrepancy generally relate to changes in the utilization of the dwelling and would be very difficult to quantify. Such factors as a different family or number of occupants in the dwelling or, more importantly, a different number of rooms in regular use fall into this category.

The change in utilization which can be understood most readily is an improvement in occupant comfort. Weatherization measures which reduce heat loss can easily result in a higher average winter-time temperature throughout the house rather than resulting exclusively in fuel savings. If such a change in utilization takes place, the program benefits the occupants, but the benefits are not reflected in the "actual" savings shown in Table 3. This factor is believed to be a primary reason for the fuel savings having a strong tendency to be less than the theoretical values.

A limited statistical analysis of the projected and actual energy savings for the twenty-two houses was performed. The objective of this analysis was to establish an adjustment factor which could be used to convert projected weatherization benefits to benefits actually observed as fuel savings. This factor was found to average 54.9% for the houses for which data were available.

Several considerations must be made if such a factor is to be

used in any evaluation of weatherization measures. First, the factor was computed for a specific combination of two weatherization measures and may not be appropriate for other measures and combinations, even though similar changes in utilization are present.

Second, the use of such a factor to indicate effectiveness of a weatherization measure disregards the true value of improvements achieved through weatherization and addresses exclusively the fuel savings. The predicted benefits are energy savings which may be realized through fuel savings, increased comfort, increased utilization of the house, or a combination of these.

Third, the data appear to indicate that this factor tends to be smaller for larger dwellings. This suggests that weatherization measures on small houses result more directly in fuel savings while on larger houses the benefits are mostly in comfort or other utilization measures. The data and analytical methods employed are not adequate to verify this. Further study on a larger data base using more sophisticated statistical correlation methods is required to prove this hypothesis.

Fourth, the limited extent of the data available on the pre-weatherization condition and usage patterns of the houses may have resulted in substantial errors in predicting the potential benefits. Limitations on the data include uncertainty in the exact dimensions of the houses, the actual before and after R-values, and the before and after infiltration rates.

III. ECONOMIC ANALYSIS

Economic analysis of each candidate weatherization measure serves two purposes:

- It determines whether each measure is economically justified in each region of the state.
- It establishes priorities among the measures to identify where emphasis and effort should be placed if funding is inadequate to implement all of the attractive opportunities.

Three basic factors are necessary to perform the analysis. First, there must be an estimate of all costs associated with implementing the weatherization measures. Since none of the measures is expected to involve recurring costs, this is limited to estimates of labor and material required to install each measure.

Second, there must be a forecast of benefits to be received. This involves the amount of annual benefit, the duration of the benefits, and any change in benefit level over time.

Third, there must be a methodology for the analysis, a basis for establishing economic viability, and a criteria for ranking alternatives.

A. Estimated Costs

Cost information was obtained from the coordinator for two of the contracting agencies -- one in the northern part of the state

and one in the south. While the costs were reported for actual houses or average houses, these were reduced to costs per unit area to correspond to the format for projected energy savings.

In some cases, the data from these sources were insufficient. In these cases, the data used in the analysis conducted in 1980 were used and adjusted for inflation.

The data collected were summarized as average values and are presented in Table 4. The data for insulating attics indicate that there is a base cost for starting the job, with the remainder being proportional to the insulation added. The figures suggest that on average the base labor cost is 20% to 50% of the labor cost to insulate a completely uninsulated attic.

B. Estimated Benefits

Benefits from weatherization may be observed in terms of fuel savings, improved comfort level, or the ability to increase utilization of the dwelling by heating and occupying more rooms. Ideally, all of these benefits may be achieved.

Unfortunately, this presents some difficulty in performing an economic analysis. Normally it is desired to evaluate the benefits in financial terms, and this is difficult with comfort level and improved space utilization. Fuel savings may only be a moderate portion of the total benefits, as discussed in Section II, and the portion is extremely difficult to determine in advance.

For this reason, this economic analysis is based on the value

TABLE 4: Cost of Weatherization Measures

Type of Measure	Material Cost	Labor Cost	Total Cost (1)
Insulation of Uninsulated Attic	12¢/ft^2 (A) 13¢/ft^2 (B)	5¢/ft^2 (A) 4¢/ft^2 (B)	17¢/ft^2
Insulation of Partially Insulated (R-10) Attic	6¢/ft^2 (A)	3¢/ft^2 (A)	9¢/ft^2
Infiltration Prevention	11¢/ft^2 (A) 12¢/ft^2 (B)	9¢/ft^2 (A) 9¢/ft^2 (B)	21¢/ft^2
Insulate Floor R-3 to R-22	21¢/ft^2 (A)(2)	6¢/ft^2 (A) 8¢/ft^2 (B)	28¢/ft^2
Insulate Walls (3)	14¢/ft^2 (B)	8¢/ft^2 (C) 4¢/ft^2 (B)	20¢/ft^2
Install Storm Windows (4)	$2.50/ft^2(B)	$1/ft^2 (B)	$3.50/ft^2
Insulate Existing Skirting	12¢/ft^2 (C)	6¢/ft^2 (C)	18¢/ft^2
Install Skirting	15¢/ft^2 (B)	8¢/ft^2 (B)	23¢/ft^2

Sources of Data Used to Develop These Costs:

(A) Mr. Will Horne, Southeast Energy Technical Group, Atlanta.
(B) Mr. Chandler Monk, Southeast Georgia Community Action Council, Moultrie.
(C) 1980 Retro-Tech evaluation with 6%/yr allowance for inflation.

Notes:

(1) All costs are based on floor area unless noted.
(2) Actual floor insulation cost is 26¢/ft^2 of insulation. This is equivalent to 21¢/ft^2 of floor area.
(3) Based on opaque wall area.
(4) Based on window area.

of the total projected heat savings from the weatherization measures, whether these are reflected in fuel savings or not. This is approximately equivalent to projecting the fuel savings which would be achieved if the same comfort levels and utilization were maintained.

Each of the weatherization measures to be prioritized is expected to be a permanent improvement to the dwelling and have a useful life of up to twenty years without reduction of benefits. On the other hand, many of the measures to reduce infiltration, such as caulking and weatherstripping, will gradually deteriorate and must be repeated periodically. For analysis purposes, these measures are assumed to have an average useful life equivalent to ten years of full benefit.

Of course, none of the weatherization measures can give benefits when the dwelling is not occupied. For this reason, it is essential that the contractors make case-by-case estimates of the useful life of the house and reduce the projected benefits, if appropriate.

The financial benefits of energy savings are dependent upon the energy saved, the price of heating fuel, and the efficiency of the heating unit in converting fuel energy to useful heat. Fuel prices are subject to unpredictable rates of increase. This has led to criticism of many economic analyses which have speculated on future energy costs. As a conservative approach, only current prices of heating fuels are used, with no allowance for inflation.

Table 5 presents current fuel prices in Georgia for common home heating fuels. This table also presents average heating system efficiencies with these fuels and the resulting cost of useful heat. The efficiencies are based on factors presented in the Project Retro-Tech Job Book.

Efficiency of natural gas fired units can vary considerably depending on the design. Unvented space heaters have a conversion efficiency of near 100%, although their ability to distribute heat throughout a house is quite limited, and this does not include the loss incurred from the high air infiltration rates required to supply fresh air for combustion. On average, however, the figures are perhaps representative of heating costs with the various fuel types. These values, along with the projection of energy savings, provide the basis for determining the economic value of benefits from weatherization.

C. Analysis Method and Results

The weatherization measures are evaluated in terms of the ratio of their benefits to their costs. An opportunity with a ratio greater than 1.0 is economically attractive, while emphasis should be placed on measures with higher ratios, if not all of the attractive measures may be implemented.

The Department of Energy guidelines suggest that benefits be represented as the sum of all benefits derived for the useful life of the measure. This is contrary to established economic analysis principles which recognize that benefits are not as

Table 5. Current Cost of Heating Fuel

Fuel	Price	Energy Cost $ per therm	Avg. Heating Efficiency	Effective Cost of Heat $ per therm
Natural Gas	$ .58/ccf	0.56	0.81	0.69
Fuel Oil	$1.00/gal	0.83	0.83	1.00
Electricity	$ .0505/kW	1.48	0.98	1.51

significant if they are delayed in coming. This is called the "time value of money," and future benefits (and costs) are normally discounted to reflect their present value. The appropriate rate of discounting is frequently a point of disagreement, but a rate of 10% per year is common for government programs.

Since each of the alternatives to be prioritized has a constant rate of benefits over the same useful life, discounting does not affect the rankings. It can, however, have a substantial effect on which measures are judged to be economically attractive. The economic analysis was performed with both discounted and non-discounted benefits so that the results could be compared.

Appendix A includes tables which present the energy savings, dollar values of benefits, payback periods, and benefit/cost ratios for each weatherization measure. Three tables present the results for non-discounted benefits for the three regions of the state, while the other three tables reflect a 10% per year discounting. Each table provides data for natural gas, oil, and electric heating systems.

Two points should be noted in these data. In addition to presenting the findings for the weatherization measures which are to be ranked, the tables present data for the impact of reducing infiltration by one air change per hour. The cost presented for this measure is the average cost for infiltration prevention as reported by the contracting agencies. Since there currently is

no basis for stating how much infiltration is reduced in each house, the benefits presented in the tables may not correspond to the costs presented. Also, since the benefits of insulating a partially insulated ceiling are dependent on the initial insulation, the tables have assumed an initial value of R-10.

Table 6 summarizes the data from Appendix A by listing the priority order of the measures and noting when each is not economically attractive.

Table 6. Priorities For Weatherization Measures

Priority	Weatherization Measure
1	Reduction of General Waste of Heat (Includes infiltration prevention and is ranked #1 per DOE direction.)
2	Insulate uninsulated attic.
3	Insulate walls, when practical.
4	Insulate fully-exposed floors.
5	Install foundation skirting, if installation of floor insulation is not practical.
6	Insulate partially-insulated attic. (Ranking assumes existing ceiling is R-10.)
7	Insulate floors, even if there is existing foundation skirting.
8	Insulate foundation skirting, if this is more practical than insulating the floor.
9	Install storm windows.

Note: All measures are economically attractive (benefit/cost ratio > 1.0) except storm windows which are not economically attractive:

(a) in south Georgia when other than electric heat is used.

(b) in middle Georgia when natural gas heat is used.

IV. ALLOCATION OF PROGRAM FUNDS

A. Indicators of Relative Need

The Department of Energy regulations governing the Weatherization Assistance Program list eight topics which the State's final implementation plan should address for each area of the state to be served by the program. The regulations also indicate that the funds are to be allocated to areas on the basis of the relative need for a weatherization project by low-income persons, taking into account these same eight factors. The factors are as follow:

1. The number of dwelling units to be weatherized.
2. The climatic conditions.
3. The type of weatherization work to be done.
4. The need for weatherization assistance among low-income persons.
5. The amount of energy to be conserved.
6. Mechanisms for providing sources of labor.
7. An estimate of the number of eligible dwelling units in which the elderly reside.
8. An estimate of the number of eligible dwelling units in which the handicapped reside.

The Department of Energy does not indicate how these factors should be quantified for regions of the state or what relative emphasis should be placed on the factors. In addition, this list

is prepared primarily to identify objectives of the implementation plan. As a result, several topics reflect what would be achieved from a given allocation rather than providing a basis for developing the allocation.

Each of the eight topics is discussed below, with emphasis on identifying which are appropriate as factors in a funding allocation formula and how these may be quantified.

Number of Units To Be Weatherized. Rather than being an appropriate factor for determining the allocation, the actual number of units to be weatherized may well be determined by the funds allocated. It is not likely that an accurate count can be made in advance.

Instead, the total number of eligible dwelling units is an appropriate factor for allocating funds, with the available funding determining the actual number of units weatherized. Under this approach, an indicator of the number of eligible dwelling units is required.

Prior to 1970, the Census Bureau collected data on "dilapidated" housing. This classification was found to be too subjective, and the 1970 and 1980 censuses collected data on housing "lacking complete plumbing facilities for exclusive use." While a dwelling's lack of plumbing may not indicate the need for weatherization, the number of dwellings lacking plumbing facilities may well be a good indicator of the number of dwellings in the same region which require weatherization. That is, both are related to the number of sub-standard dwellings in

the area. For this reason, these data are used for the first factor of the formula.

The Climatic Conditions. Thirty-year average data is available from the National Oceanographic and Atmospheric Administration for both heating degree-days and cooling degree-days for nine zones of Georgia. These data reflect the climatic conditions of importance to the program. As would be expected, heating requirements are dominant in the northern part of the state while cooling requirements are dominant in the southern part. When the heating degree-days and cooling degree-days are added, there is less than a 10% variation from the median.

A serious consideration is whether cooling requirements are important to the funding allocation. Under the Weatherization Assistance Program, only very limited measures may be implemented to assist in meeting cooling needs of the dwellings. For this reason, the cooling degree-day data are disregarded in the allocation formula developed.

Weatherization Work To Be Done. For two reasons this factor is not included in the funding allocation formula. First, the types of weatherization measures implemented are determined by economic issues, site specific conditions, and available funding. As with the number of actual dwellings to be weatherized, the weatherization work to be done should be a result rather than a cause of funding allocation. Second, for similar climatic conditions and similar housing, the work to be

done in different areas of the state should be the same. Thus, having both the climatic conditions and the work to be done as factors in the formula should be redundant.

Need for Assistance Among Low-Income Persons. Both income level and poverty status are reflected by Census Bureau data. The Census Bureau summary category which best reflects this topic is the number of families and non-family householders with income below the poverty level.

While these data are available for each county, there is no summary currently available which cross categorizes poverty status with lack of plumbing (need for weatherization) in the dwelling. Although it may reasonably be assumed that poverty status and substandard housing would correlate well, the data to verify this are not currently available to the public. If perfect correlation is assumed, there is no need to include both factors in the formula. If no correlation is assumed, the currently available data are suitable for developing the formula.

The formula developed under this study includes the total number of poverty households in each region. As additional census data are made available to the public, a cross categorization of poverty status with housing quality may be developed and substituted in the formula.

Amount of Energy To Be Conserved. This consideration, again, will correlate to the climatic conditions, the number of dwellings to be weatherized, and the weatherization work to be

done. Including it as a factor in the allocation formula will be redundant.

Mechanisms for Providing Sources of Labor. This item essentially indicates whether an agency is capable of implementing the program effectively. It is not a factor which can be handled in the same manner as the others. Instead, the allocation formula determines relative need in each area without regard for the ability to provide assistance. It then allows the Office of Energy Resources to rate an agency's effectiveness and include this as a factor in determining the agency's share of program funds.

Eligible Dwellings in Which the Elderly Reside. Age is also reflected in the Census Bureau data. If a definition of "elderly" is accepted, the data indicate the number of elderly in each county. The same problem exists, however, in cross categorization of sub-standard housing with age. Such summary data have not yet been released. The funding allocation formula includes a term for total number of persons 65 years of age or over. Again, as additional census data are available to the public, the formula may be modified to reflect the actual number of sub-standard dwellings in which the elderly reside.

Eligible Dwellings in Which the Handicapped Reside. Handicap status is indicated in census data in terms of both work handicaps and transportation handicaps. Work handicaps appear to be more closely related to the interests of the program. Again, the cross categorization of housing condition with handicap

status is not yet available, and an interim formula has been developed. The specific census summary category which is included is the total of non-institutional persons 16 to 64 years of age with a work disability.

In summary, the funding allocation formula is based on five quantitative measures drawn from National Oceanographic and Atmospheric Administration data and several Census Bureau publications:

1. Heating degree-days.
2. Dwelling units lacking complete plumbing facilities for exclusive use (total of owner and renter occupied units).
3. Families and non-family householders with income below the poverty level.
4. Persons 65 years of age and over.
5. Non-institutional persons 16 to 64 years with a work disability.

B. Development of the Allocation Formula

Data were collected for each of these items for each county in Georgia and for the City of Atlanta. Data for Fulton County were recorded excluding the City of Atlanta, to aid in allocating funds between agencies serving the city and the remainder of the county.

These data were used in a micro-computer based program for computation of the funding allocation. The formula which was

developed uses two steps to determine the appropriate funding allocation. First, the relative need for assistance is determined for each county. Second, each agency's share is determined by the total relative need in the counties the agency represents and by the Office of Energy Resources' rating of the agency.

The relative need in a county is computed by an equation of the form:

$$\text{Need} = W_1X_1 + W_2X_2 + \cdots + W_5X_5$$

where X_i = Ratios of quantitative measures of need in the county to the average for all counties

W_i = Weighting factors to reflect relative importance of the five measures

The critical item in this process is selection of proper weighting factors for the five parameters indicating need. Preliminary weighting factors were selected by the Office of Energy Resources as follow:

Units w/o plumbing	0.1
Heating degree-days	0.3
Poverty families	0.4
Population 65 and over	0.1
Handicapped population	0.1

This equation resulted in "County Need Factors" which average 1.00 and which should reflect overall need for assistance from the program. The county factors for counties represented by each agency were summed as an "Agency Factor" to indicate need within

the region served by the agency. Then, a funding share was computed as the ratio of the agency factor to the total of all agency factors, multiplied by the agency rating.

Initially all agencies are rated equally at 1.0. Both the agency ratings and the weighting factors may be adjusted by the Office of Energy Resources, if required, giving revised, equitable funding shares for each agency.

Appendix B presents a listing of the output from the micro-computer program, showing the data for each county, the county need factors, and the agency funding shares based on the weighting factors and agency ratings listed above.

This listing provides a basis for appropriate allocation of program funds to the implementing agencies, while the flexibility of the formula allows for adjustments as additional data are available, as emphasis (weighting) is shifted to other indicators of need, and as specific rating factors for agencies are developed.

Appendix A

Results of Economic Analysis of Weatherization Measures

Weatherization Assistance Program Economic Analysis

Region:	North Georgia	Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	3358	Cost per useful therm ($):	0.69	1.00	1.51
Floor Exposure:	1.00	No Discounting of Future Benefits			

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Non-discounted Payback Period (Years) Gas	Oil	Elect.	Non-discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.232	0.16	0.23	0.35	1.06	0.73	0.49	18.83	27.30	41.22
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.044	0.03	0.04	0.07	2.97	2.05	1.36	6.73	9.76	14.74
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.232	0.16	0.23	0.35	1.75	1.21	0.80	11.44	16.57	25.03
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.215	0.15	0.21	0.32	1.35	0.93	0.62	14.83	21.49	32.46
Install Storm Windows (1 sq ft of window)	3.50	20	0.604	0.42	0.60	0.91	8.39	5.79	3.83	2.38	3.45	5.22
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.134	0.09	0.13	0.20	2.48	1.71	1.13	8.06	11.68	17.64
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.054	0.04	0.05	0.08	4.86	3.35	2.22	4.12	5.97	9.01
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.250	0.17	0.25	0.38	2.95	2.04	1.35	6.77	9.82	14.82
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.129	0.09	0.13	0.19	2.36	1.63	1.08	4.24	6.14	9.27

Weatherization Assistance Program Economic Analysis

Region:	Middle Georgia		Fuel Tyoe:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	2474		Cost per useful therm ($):	0.69	1.00	1.51
Floor Exposure:	1.00		No Discounting of Future Benefits			

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Non-discounted Payback Period (Years) Gas	Oil	Elect.	Non-discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.171	0.12	0.17	0.26	1.44	0.99	0.66	13.88	20.11	30.37
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.032	0.02	0.03	0.05	4.03	2.78	1.84	4.96	7.19	10.86
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.171	0.12	0.17	0.26	2.37	1.64	1.08	8.43	12.21	18.44
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.158	0.11	0.16	0.24	1.83	1.26	0.84	10.93	15.84	23.91
Install Storm Windows (1 sq ft of window)	3.50	20	0.445	0.31	0.45	0.67	11.39	7.86	5.20	1.76	2.54	3.84
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.099	0.07	0.10	0.15	3.37	2.32	1.54	5.94	8.61	12.99
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.040	0.03	0.04	0.06	6.59	4.55	3.01	3.03	4.40	6.64
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.184	0.13	0.18	0.28	4.01	2.77	1.83	4.99	7.23	10.92
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.095	0.07	0.10	0.14	3.20	2.21	1.46	3.12	4.52	6.83

Weatherization Assistance Program Economic Analysis

Region:	South Georgia		Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	1880		Cost per useful therm ($):	0.69	1.00	1.51
Floor Exposure:	1.00		No Discounting of Future Benefits			

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Non-discounted Payback Period (Years) Gas	Oil	Elect.	Non-discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.130	0.09	0.13	0.20	1.90	1.31	0.87	10.54	15.28	23.08
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.025	0.02	0.02	0.04	5.30	3.66	2.42	3.77	5.46	8.25
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.130	0.09	0.13	0.20	3.12	2.16	1.43	6.40	9.28	14.01
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.120	0.08	0.12	0.18	2.41	1.66	1.10	8.30	12.03	18.17
Install Storm Windows (1 sq ft of window)	3.50	20	0.338	0.23	0.34	0.51	14.99	10.34	6.85	1.33	1.93	2.92
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.075	0.05	0.08	0.11	4.43	3.06	2.03	4.51	6.54	9.87
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.030	0.02	0.03	0.05	8.67	5.98	3.96	2.31	3.34	5.05
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.140	0.10	0.14	0.21	5.27	3.64	2.41	3.79	5.50	8.30
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.072	0.05	0.07	0.11	4.22	2.91	1.93	2.37	3.44	5.19

Weatherization Assistance Program Economic Analysis

Region:	North Georgia		Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	3358		Cost per useful therm ($):	0.69	1.00	1.51
Floor Exposure:	1.00		Discount rate per year:	0.10		

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Discounted Payback Period (Years) Gas	Oil	Elect.	Discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.232	0.16	0.23	0.35	1.18	0.80	0.52	8.02	11.62	17.55
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.044	0.03	0.04	0.07	3.70	2.41	1.53	2.87	4.15	6.27
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.232	0.16	0.23	0.35	2.02	1.35	0.87	4.87	7.05	10.65
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.215	0.15	0.21	0.32	1.52	1.02	0.67	6.31	9.15	13.82
Install Storm Windows (1 sq ft of window)	3.50	20	0.604	0.42	0.60	0.91	19.18	9.08	5.07	1.01	1.47	2.22
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.134	0.09	0.13	0.20	2.99	1.97	1.26	3.43	4.97	7.51
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.054	0.04	0.05	0.08	6.97	4.28	2.63	1.75	2.54	3.84
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.250	0.17	0.25	0.38	3.67	2.39	1.52	2.88	4.18	6.31
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.129	0.09	0.13	0.19	2.82	1.87	1.20	2.60	3.77	5.70

Weatherization Assistance Program Economic Analysis

Region:	Middle Georgia	Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	2474	Cost per useful therm ($):	0.69	1.00	1.51
Floor Exposure:	1.00	Discount rate per year:	0.10		

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Discounted Payback Period (Years) Gas	Oil	Elect.	Discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.171	0.12	0.17	0.26	1.63	1.10	0.71	5.91	8.56	12.93
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.032	0.02	0.03	0.05	5.41	3.42	2.14	2.11	3.06	4.62
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.171	0.12	0.17	0.26	2.84	1.88	1.20	3.59	5.20	7.85
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.158	0.11	0.16	0.24	2.12	1.42	0.92	4.65	6.74	10.18
Install Storm Windows (1 sq ft of window)	3.50	20	0.445	0.31	0.45	0.67	Inf.	16.17	7.71	0.75	1.08	1.64
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.099	0.07	0.10	0.15	4.31	2.78	1.75	2.53	3.66	5.53
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.040	0.03	0.04	0.06	11.29	6.36	3.76	1.29	1.87	2.83
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.184	0.13	0.18	0.28	5.37	3.40	2.12	2.12	3.08	4.65
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.095	0.07	0.10	0.14	4.05	2.62	1.66	1.92	2.78	4.20

Weatherization Assistance Program Economic Analysis

Region:	South Georgia		Fuel Type:	Nat. Gas	Oil	Elect.
Heating degree-days/yr:	1880		Cost per useful therm ($):	0.69	1.00	1.51
Floor Exposure:	1.00		Discount rate per year:	0.10		

Weatherization Measure	Cost $	Useful Life (Years)	Benefit (Therms/ Year)	Benefit ($ / Year) Gas	Oil	Elect.	Discounted Payback Period (Years) Gas	Oil	Elect.	Discounted Benefit/Cost Ratio Gas	Oil	Elect.
Insulate Uninsulated Attic to R-22 (1 sq ft)	0.17	20	0.130	0.09	0.13	0.20	2.21	1.47	0.95	4.49	6.51	9.82
Insulate Partially Insulated (R-10) Attic to R-22 (1 sq ft)	0.09	20	0.025	0.02	0.02	0.04	7.93	4.78	2.91	1.61	2.33	3.51
Insulate Floor From R-3 to R-22 (No Skirting) (1 sq ft)	0.28	20	0.130	0.09	0.13	0.20	3.93	2.55	1.62	2.73	3.95	5.96
Insulate Walls From R-3 to R-15 (1 sq ft of wall)	0.20	20	0.120	0.08	0.12	0.18	2.89	1.91	1.22	3.53	5.12	7.73
Install Storm Windows (1 sq ft of window)	3.50	20	0.338	0.23	0.34	0.51	Inf.	Inf.	12.12	0.57	0.82	1.24
Install Skirting (No Floor Insulation) (1 sq ft of floor)	0.23	20	0.075	0.05	0.08	0.11	6.14	3.83	2.37	1.92	2.78	4.20
Insulate Existing or New Skirting (1 sq ft of floor)	0.18	20	0.030	0.02	0.03	0.05	21.19	9.57	5.30	0.98	1.42	2.15
Install Skirting & Insulate Floor (1 sq ft of floor)	0.51	20	0.140	0.10	0.14	0.21	7.86	4.75	2.89	1.61	2.34	3.53
Reduce Draft Index by one air change per hour (8 ft ceilings) (1 sq ft floor area)	0.21	10	0.072	0.05	0.07	0.11	5.74	3.61	2.25	1.46	2.11	3.19

Appendix B

Funding Allocation Formula Sample Printout

WEATHERIZATION ASSISTANCE PROGRAM
Funding Allocation Formula

	Units w/o Plumbing	Heating Deg-Days	Poverty Families	Pop. Over 65	Handicap. Pop.	
Wt. Factor->	0.20	0.20	0.40	0.10	0.10	
Norm ->	372	2522	2003	3059	2253	
County						County Factor
Appling	219	1778	1434	1537	1405	0.65775
Atkinson	211	1932	632	673	623	0.44258
Bacon	53	1778	844	970	798	0.40518
Baker	83	1932	386	484	341	0.30591
Baldwin	328	2471	1540	2731	2221	0.86776
Banks	229	3284	440	1003	741	0.53718
Barrow	343	3422	1361	2347	1646	0.87744
Bartow	608	3368	2100	3857	3167	1.28012
Ben Hill	173	1932	1520	2047	1219	0.67081
Berrien	128	1932	989	1525	1064	0.51664
Bibb	630	2471	10290	15209	12021	3.62013
Bleckley	279	2471	690	1191	828	0.55952
Brantley	98	1778	574	801	689	0.36511
Brooks	515	1932	1546	2033	1158	0.85680
Bryan	208	1778	666	755	813	0.44665
Bulloch	695	2306	2541	3265	2541	1.28360
Burke	793	2306	1786	2137	1590	1.10649
Butts	339	2471	662	1345	1051	0.60113
Calhoun	242	1932	569	810	385	0.44059
Camden	224	1778	960	1065	965	0.53084
Candler	181	2306	682	1032	646	0.47884
Carroll	760	2646	3291	5571	4145	1.64186
Catoosa	168	3368	1745	3076	2563	0.92023
Charlton	189	1778	476	681	583	0.38587
Chatham	709	1778	12873	20240	12546	4.31117
Chattahoochee	63	2646	334	191	813	0.35277
Chatooga	319	3368	1428	2617	2111	0.90309
Cherokee	455	3422	1983	3858	2914	1.16755
Clarke	336	3422	6034	5516	3433	1.98963
Clay	228	1932	437	548	274	0.39321
Clayton	362	2646	4064	6194	7955	1.77157
Clinch	237	1932	571	609	487	0.43625
Cobb	653	3422	7232	15642	14736	3.23199
Coffee	340	1932	2175	2642	2545	0.96972
Colquitt	381	1932	2553	4216	2963	1.13725
Columbia	378	2306	1527	1982	2435	0.86398
Cook	167	1932	897	1549	973	0.51599
Coweta	650	2646	2422	4153	2974	1.31085
Crawford	333	2471	494	707	559	0.52167

Crisp	219	1932	1776	2242	1259	0.75482
Dade	198	3368	782	999	986	0.60620
Dawson	71	3422	345	504	352	0.41060
Decatur	599	1932	1856	2974	1905	1.02779
DeKalb	961	3422	16385	32269	22816	6.12737
Dodge	393	2471	1757	2082	1610	0.89772
Dooly	295	1932	1169	1402	942	0.63297
Dougherty	523	1932	6335	6872	5752	2.17938
Douglas	238	2646	1484	3219	3098	0.87692
Early	446	1932	1269	1688	906	0.74191
Echols	62	1932	204	261	207	0.24504
Effingham	358	2306	1027	1531	1347	0.69036
Elbert	488	3284	1418	2353	1333	0.94218
Emanual	581	2306	1825	2433	1840	1.02101
Evans	187	1778	746	1017	660	0.45310
Fannin	347	3422	1415	2123	1458	0.87471
Fayette	220	2646	623	1764	1284	0.56725
Floyd	543	3368	4071	8932	5627	1.91378
Forsyth	265	3422	1180	2300	1745	0.80220
Franklin	223	3284	1258	1987	1254	0.75222
Fulton (ex Atl)	648	3422	3844	11879	6122	2.04753
Atlanta	2168	3422	41458	47481	30004	12.59920
Gilmer	299	3422	936	1369	1203	0.71729
Glascock	70	2306	189	328	213	0.27847
Glynn	236	1778	3186	5871	4031	1.27493
Gordon	351	3368	1629	2862	2080	0.96707
Grady	404	1932	1743	2550	1540	0.87028
Greene	540	2471	995	1598	920	0.77820
Gwinnett	649	3422	3618	8117	7199	1.92775
Habersham	303	3284	1436	2614	2043	0.88630
Hall	659	3422	3390	7171	5584	1.78501
Hancock	577	2471	987	1089	738	0.77178
Haralson	280	2646	1170	2100	1472	0.72807
Harris	602	2646	1019	1826	1122	0.84664
Hart	325	3284	1236	2201	1500	0.82060
Heard	237	2646	412	766	621	0.47222
Henry	511	2646	1381	3044	2234	0.95913
Houston	420	2471	2839	3841	5505	1.35864
Irwin	181	1932	702	1196	592	0.45614
Jackson	400	3422	1405	2714	2048	0.94673
Jasper	258	2471	577	991	458	0.50270
Jeff Davis	196	1932	726	1138	1001	0.48525
Jefferson	688	2306	1840	2317	1275	1.05270
Jenkins	353	2306	925	994	948	0.63204
Johnson	333	2471	784	1109	725	0.60008
Jones	314	2471	793	1230	1110	0.61270
Lamar	267	2646	719	1440	938	0.58576
Lanier	97	1932	494	639	484	0.34642
Laurens	806	2471	2667	4085	3052	1.43104
Lee	167	1932	594	763	482	0.40801
Liberty	398	1778	1904	1249	2067	0.86784
Lincoln	230	3284	418	807	522	0.51720

Long	105	1778	343	386	367	0.29490
Lowndes	566	1932	4558	5583	4174	1.73553
Lumpkin	190	3422	645	946	798	0.56875
McDuffie	451	2306	1394	1740	1469	0.82591
McIntosh	226	1778	831	898	842	0.49524
Macon	433	2646	1355	1571	1073	0.81231
Madison	277	3284	1086	1758	1299	0.74143
Marion	310	2646	538	607	505	0.52630
Meriwether	822	2646	1555	2533	1419	1.10829
Miller	159	1932	657	927	448	0.42013
Mitchell	361	1932	1818	2279	1505	0.85171
Monroe	471	2471	749	1531	1061	0.69603
Montgomery	177	2471	506	845	557	0.44458
Morgan	305	2471	747	1400	659	0.58422
Murray	309	3368	1010	1518	1412	0.74730
Muscogee	454	2646	11054	14280	12050	3.66281
Newton	701	2471	1709	3377	1977	1.11243
Oconee	183	3422	554	1075	728	0.54792
Oglethorpe	359	3284	576	1062	636	0.63153
Paulding	358	3368	1381	2302	2012	0.89999
Peach	363	2471	1523	1586	1528	0.81500
Pickens	421	3422	779	1442	1009	0.74534
Pierce	169	1778	977	1263	1142	0.51898
Pike	234	2646	409	1005	599	0.47684
Polk	451	3368	2179	3971	3016	1.20847
Pulaski	202	2471	813	1145	716	0.53618
Putnam	229	2471	730	1106	731	0.53353
Quitman	168	1932	293	339	214	0.32269
Rabun	199	3284	803	1463	968	0.61864
Randolph	493	1932	1080	1471	675	0.71211
Richmond	660	2306	11221	14397	11550	3.76163
Rockdale	171	2471	1029	2410	1804	0.65228
Schley	122	2646	326	426	245	0.36539
Screven	516	2306	1564	1730	1186	0.88193
Seminole	185	1932	759	1134	664	0.47084
Spalding	423	2646	2923	4915	3502	1.33713
Stephens	261	3284	1372	2600	1694	0.83499
Stewart	357	1932	725	833	566	0.54238
Sumter	804	1932	2195	3111	2010	1.21489
Talbot	478	2646	459	863	513	0.60961
Taliaferro	149	2471	243	426	209	0.34786
Tattnall	259	1778	1640	1977	1469	0.73762
Taylor	291	2646	626	1028	650	0.55385
Telfair	272	1932	1041	1544	1091	0.60630
Terrell	521	1932	1142	1519	710	0.74267
Thomas	605	1932	2721	4331	2749	1.28555
Tift	435	1932	2401	3102	2490	1.07854
Toombs	322	1778	2042	2205	2191	0.89127
Towns	73	3284	518	921	448	0.45316
Treutlen	219	2471	550	808	676	0.48002
Troup	1080	2646	3456	6314	3799	1.85586
Turner	210	1932	886	1092	732	0.51129

Twiggs	425	2471	584	884	589	0.59624
Union	207	3422	967	1376	876	0.65971
Upson	679	2646	1381	3483	2202	1.06243
Walker	430	3368	2942	5903	4281	1.46882
Walton	541	3422	1828	3138	2331	1.13345
Ware	392	1778	2728	4010	3441	1.18038
Warren	280	2306	623	884	498	0.50891
Washington	962	2471	1613	2250	1468	1.17422
Wayne	254	1778	1439	2037	1908	0.71624
Webster	133	1932	224	285	180	0.28681
Wheeler	135	2471	548	734	561	0.42692
White	170	3422	738	1207	764	0.58358
Whitfield	425	3368	3013	5367	4499	1.47246
Wilcox	180	1932	797	1029	617	0.47022
Wilkes	333	3284	955	1546	774	0.71517
Wilkinson	407	2471	629	1126	730	0.60971
Worth	488	1932	1341	1939	1143	0.79760
					Sum:	160.00000

	Agency	Total of County Factors	Agency Rating	Agency Factor	Funding Share
1	Albany Urban League Albany, GA (Dougherty)	2.179	1.000	2.179	0.014680
2	Altamaha Area CAA, Inc. Reidsville, GA (Appling, Bulloch, Candler, Evans Jeff Davis, Tattnall, Toombs, Wayne)	5.704	1.000	5.704	0.038420
3	ACTION, Inc. Athens, GA (Barrow, Clarke, Elbert, Greene, Madison, Morgan, Oglethorpe, Walton)	7.678	1.000	7.678	0.051719
4	Central Savannah River Area EOA, Inc. Augusta, GA (Burke, Columbia, Emanuel, Glascock, Jefferson, Jenkins, Lincoln, McDuffie, Richmond, Screven, Taliaferro, Wilkes)	12.004	1.000	12.004	0.080861

5	Clayton Co. CSA, Inc. Forrest Park, GA (Clayton, Fayette, Henry)	3.298	1.000	3.298	0.022215
6	Coastal Georgia Area CAA, Inc. Brunswick, GA (Bryan, Camden, Glynn, Liberty, Long, McIntosh)	3.910	1.000	3.910	0.026340
7	Coastal Plain Area EOA, Inc. Valdosta, GA (Ben Hill, Brooks, Echols, Irwin, Lanier, Lowndes, Tift, Turner)	5.901	1.000	5.901	0.039746
8	Community Action for Improvement, Inc. LaGrange, GA (Carroll, Coweta, Heard, Merriwether, Troup)	6.389	1.000	6.389	0.043037
9	DeKalb County EOA, Inc. Decatur, GA (DeKalb)	6.127	1.000	6.127	0.041274
10	Economic Opportunity Atlanta, Inc. Atlanta, GA (Douglas, Fulton, Gwynnett, Rockdale)	5.504	1.000	5.504	0.037078
11	EOA for Savannah-Chatham County Areas Savannah, GA (Chatham)	4.311	1.000	4.311	0.029040
12	Enrichment Services Program, Inc. Columbus, GA (Chattahoochee, Clay, Harris, Muscogee, Quitman, Randolph, Stewart, Talbot)	7.442	1.000	7.442	0.050131
13	Heart of Georgia CAA, Inc. Eastman, GA (Bleckley, Dodge, Laurens, Montgomery, Pulaski, Telfair, Treutlen, Wheeler, Wilcox)	5.852	1.000	5.852	0.039422
14	Macon-Bibb County EOC Macon, GA (Bibb, Jones, Lamar)	4.819	1.000	4.819	0.032458
15	Marietta/Cobb CSC Marietta, GA (Cobb)	3.232	1.000	3.232	0.021771

16	Middle Georgia CAA, Inc. Warner Robins, GA (Houston, Monroe, Peach, Twiggs)	3.466	1.000	3.466	0.023346
17	Migrant and Seasonal Farmworkers Assoc. Waycross, GA (Ware[40%])	0.472	1.000	0.472	0.003180
18	Ninth District Opportunity, Inc. Gainesville, GA (Banks, Dawson, Forsyth, Franklin, Habersham, Hart, Lumpkin, Rabun, Stephens, Towns, Union, White)	7.928	1.000	7.928	0.053402
19	North Georgia CAA, Inc. Jasper, GA (Cherokee, Fannin, Gilmer, Murray, Pickens, Whitfield)	5.725	1.000	5.725	0.038561
20	Northwest Georgia EOA, Inc. LaFayette, GA (Chattooga, Dade, Walker)	2.978	1.000	2.978	0.020060
21	Overview Corporation Milledgeville, GA (Baldwin, Hancock, Jasper, Johnson, Putnam, Washington, Wilkinson)	5.060	1.000	5.060	0.034083
22	Slash Pine CAA, Inc. Waycross, GA (Atkinson, Bacon, Brantley, Charlton Clinch, Coffee, Pierce, Ware[60%])	4.232	1.000	4.232	0.028506
23	Southeast Energy Technical Group Atlanta, GA (City of Atlanta)	12.599	1.000	12.599	0.084868
24	Southwest Georgia CAC, Inc. Moultrie, GA (Baker, Calhoun, Colquitt, Decatur, Early, Grady, Lee, Miller, Mitchell, Seminole, Terrell, Thomas, Worth)	9.500	1.000	9.500	0.063993

25	Tallatoona EOA, Inc. Cartersville, GA (Bartow, Floyd, Gordon, Haralson, Paulding, Polk)	6.998	1.000	6.998	0.047135
26	West Central Georgia CAC, Inc. Montezuma, GA (Crisp, Dooley, Macon, Marion Schley, Sumter, Taylor, Webster)	5.147	1.000	5.147	0.034672
	Sub-total:	148.457		148.457	1.000000
	No Agency:	11.543			
	Total:	160.000			